This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com

Digitized by Google

THE UNIVERSITY

OF ILLINOIS

LIBRARY

620.5

RO

n.s.,v. 15

ALTGELD HALL STACKS

Digitized by Google

Digitized by Google

Digitized by Google

REMOTE STORAGE

Digitized by Google

Digitized by Google

THE ROYAL ENGINEERS JOURNAL.

VOLUME XV.

JANUARY TO JUNE, 1912.

CHATHAM:
ROYAL ENGINEERS INSTITUTE.
AGENTS AND PRINTERS: W. & J. MACKAY & CO., LTD.

Digitized by Google

6205
R O
M.S., V 6

VOLUME XV.

No. 1. JANUARY... ... ... Pages 1— 72
,, 2. FEBRUARY ... ... ,, 73—136
,, 3. MARCH ... ... ,, 137—208
,, 4. APRIL ... ... ,, 209—280
,, 5. MAY ... ... ,, 281—344
,, 6. JUNE ... ... ,, 345—432

Digitized by Google

230888

Digitized by Google

Digitized by Google

PAGE.

"NEST" (OR "RECESS") FIRE TRENCHES. (From the *Injenerni Jurnal*) ... 263

NOTE ON THE GRAPHIC CHART, showing the scantling and number of road-bearers of various timbers to carry typical kinds of military traffic upon bays of different spans, by Lieut. S. M. Collins, R.E. (T.), M.A., Barrister-at-Law ... 157

NOTES ON THE INSTRUCTIONS FOR CROSSING AND DESTRUCTION OF OBSTACLES IN FORTIFICATION (PROVISIONAL). WAR OFFICE (FRANCE). 1909. (Translated by Lieut. E. Rogers, R.E.) 415

NOTES ON THE PANAMA CANAL, by Lieut. R. A. Owen, R.E. ... 219

NOTICES OF MAGAZINES:—

Rivista di Artiglieria e Genio, by Col. Sir E. T. Thackeray, V.C., K.C.B., late R.E. 133, 277, 335, 423

PANAMA CANAL, NOTES ON, by Lieut. R. A. Owen, R.E. ... 219

PASLEY, CENTENARY REMINISCENCES OF SIR CHARLES, by Col. B. R. Ward, R.E. 291

PETAWAWA CAMP, CANADA, by Lt.-Col. G. S. Maunsell, R.C.E. 281

PONTOON BRIDGE FOR STEAM TRANSPORT, by Capt. W. L. de M. Carey, R.E. 81, 141

RECENT PUBLICATIONS OF MILITARY INTEREST 71, 337

R.E. MUSEUM, THE, by Major W. A. Harrison, late R.E. ... 345

R.E. OFFICERS, THE DUAL ROLE OF, by Major A. F. Sargeaunt, R.E. 1

REVIEWS:—

Histoire Élémentaire de l'Architecture Militaire depuis l'Antiquité jusqu'au XVIe Siécle. Par Albert Mersier (2nd Lieut. K. J. Martin, R.E.) ... 69

Reinforced Concrete Construction 70

SANDBAGS AND THEIR APPLICATION DURING THE RUSSO-JAPANESE WAR. (Translated from the *Injenerni Jurnal* by Lt.-Col. F. E. G. Skey, R.E.)... 271

SEARCH FOR SECRECY IN RADIO-TELEGRAPHIC COMMUNICATIONS, THE. (Translated from a pamphlet of the Congresso Internazionale della applicazioni electriche by Lieut. A. H. Scott, R.E.) 127

STEAM TRANSPORT, A PONTOON BRIDGE FOR, by Capt. W. L. de M. Carey, R.E. 81, 141

STEEL CONCRETE CULVERTS, by Capt. E. D. Carr-Harris, R.E... 359

SOME NOTES ON FIELDWORKS, by Major J. C. Matheson, R.E. ... 73

SUBMARINE CABLES FOR LONG DISTANCE TELEPHONE CIRCUITS. (Extracts from a paper by Major W. A. J. O'Meara, C.M.G., late R.E.) 119, 183

SUPPLY OF EXPLOSIVE STORES IN THE FIELD, by Capt. N. W. Webber, R.E. 89

SURVEY PROBLEM IN SIEGE WARFARE, A, by Capt. W. A. de C. King, R.E. 355

TRANSYRIAN RAILWAY, THE. (Translated from the *Revue Militaire des Armées Étrangères* by Lieut. A. H. Scott, R.E.) 129

TRAIN CONTROL, THE A.B.C. SYSTEM OF, by Major H. F. E. Freeland, M.V.O., R.E. 361

Digitized by Google

Index to Authors.

(*Memoirs and Reviews Omitted.*)

	Page.
Borradaile, Capt. B.	279
Carey, Capt. W. L. de M.	81, 141, 432
Carr-Harris, Capt. E. D. ...	359
Collins, Lieut. S. M.	157
Congreve, Brig.-Gen. W. N. ..	149
Freeland, Major H. F. E. ...	361
Grove, Capt. T. T.	63
Harrison, Major W. A.	345
Hinks, A. R.	91
'Inspector'	7
Kenyon, Col. E. R.	37, 107, 163, 245, 309, 383
King, Capt. W. A. de C.	355
Macartney-Filgate, Col. E. A.	289
Matheson, Major J. C. ...	73, 207
Maunsell, Lt.-Col. G. S. ...	281
McClintock, Bt. Major R. L. ...	137
Mildred, Major S.	329
O'Meara, Major W. A. J.	119, 183
Owen, Lieut. R. A.	219
Rogers, Lieut. E.	415
Sankey, Capt. C. E. P.	209
Sargeaunt, Major A. F.	1
Scott, Lieut. A. H. ...	51, 127, 129
Skey, Lt.-Col. F. E. G. ...	53, 271
Thackeray, Col. Sir Edward T.	133, 277, 335, 423
Ward, Col. B. R.	291, 429
Webber, Capt. N. W.	89
Wilson, Major C. S.	215

Digitized by Google

Subject Index.

Original Articles are entered in thick type; Translations, Reviews, and Notices of Magazines in thin type.

PAGE.

A.B.C. SYSTEM OF TRAIN CONTROL, by Major H. F. E. Freeland, M.V.O., R.E. 361

ANCHORAGES FOR MILITARY BRIDGES, THE HOLDING POWER OF EARTH IN CONNECTION WITH, by Capt. C. E. P. Sankey, R.E. 209

AUTOMATIC LAND MINES AT PORT ARTHUR. (Translated from the *Injenerni Jurnal* by Lt.-Col. F. E. G. Skey, R.E.) 53

BOOKS RECEIVED 136, 208

BRIDGE, PONTOON, FOR STEAM TRANSPORT, by Capt. W. L. de M. Carey, R.E. 81, 141

BRIDGES, KACHIN, by Bt. Major R. L. McClintock, D.S.O., R.E. ... 137

CENTENARY REMINISCENCES OF SIR CHARLES PASLEY, by Col. B. R. Ward, R.E. 291

CORRESPONDENCE:—

A Pontoon Bridge for Steam Transport, by Major J. C. Matheson, R.E. ... 207

,, ,, ,, ,, by Capt. W. L. Carey, R.E. ... 432

Pasley on Napoleon, by Col. B. R. Ward, R.E. 429

Tactical Reconnaissance, by Capt. B. Borradaile, R.E. 279

CULVERTS, STEEL CONCRETE, by Capt. E. D. Carr-Harris, R.E.... 359

DRAWBRIDGE, IMPROVISED, by Major C. S. Wilson, R.E. ... 215

DUAL ROLE OF R.E. OFFICERS, by Major A. F. Sargeaunt, R.E. 1

ECHOES FROM THE ENGINE ROOM, by "Inspector" 7

ELECTROLYTIC A.C.—D.C. TRANSFORMER. (Translated from the *Kriegstechnische Zietschrift* by Lieut. A. H. Scott, R.E.) 51

ENGINEERS AT THE AUTUMN MANŒUVRES OF THE 20TH (FRENCH) ARMY CORPS IN 1910. (Translated from the *Revue Militaire Générale* by Capt. T. T. Grove, R.E.) 63

EXPLOSIVE STORES, SUPPLY OF, IN THE FIELD, by Capt. N. W. Webber, R.E. 89

Digitized by Google

PAGE.

FIELDWORKS, SOME NOTES ON, by Major J. C. Matheson, R.E. ... 73

FLETCHER, LIEUT.-COL. SIR RICHARD, BART., K.C.H., R.E., by Col. E. A. Macartney-Filgate... 289

GRAPHIC CHART, NOTE ON THE, showing the scantling and number of road-bearers of various timbers to carry typical kinds of military traffic upon bays of different spans, by Lieut. S. M. Collins, R.E. (T.), M.A., Barrister-at-Law ... 157

GREAT SIEGE OF GIBRALTAR (1779-83), A LADY'S EXPERIENCES IN THE, by Col. E. R. Kenyon, R.E. ... 37, 107, 163, 245, 309, 383

HISTORICAL DOCUMENTS OF MAJOR-GENERAL SIR J. T. JONES, BART., K.C.B., R.E. 27, 159, 229

HOLDING POWER OF EARTH IN CONNECTION WITH ANCHORAGES FOR MILITARY BRIDGES, THE, by Capt. C. E. P. Sankey, R.E. 209

HORIZONTAL ANTENNAE. (Translated from the *Armeeblatt* by Major S. Mildred, R.E.) 329

IMPROVISED DRAWBRIDGE, by Major C. S. Wilson, R.E. ... 215

JONES, HISTORICAL DOCUMENTS OF MAJOR-GENERAL SIR J. T., BART., K.C.B., R.E. 27, 159, 229

KACHIN BRIDGES, by Bt. Major R. L. McClintock, D.S.O., R.E. ... 137

LADY'S EXPERIENCES IN THE GREAT SIEGE OF GIBRALTAR, 1779-83, A, by Col. E. R. Kenyon, R.E. ... 37, 107, 163, 245, 309, 383

LATEST DEVELOPMENTS IN MUSKETRY, THE, by Brig.-Gen. W. N. Congreve, V.C., C.B., M.V.O. 149

MAP PROJECTIONS IN ACTUAL USE, by Arthur R. Hinks, M.A. ... 91

MEMOIRS:—

Lt.-Col. Henry F. C. Lewin, R.E., by Col. R. H. Vetch, C.B., late R.E. 45

Col. H. C. Seddon, R.E. 327

Gen. Sir A. Taylor, G.C.B., R.E. (Bengal), by Col. Sir E. Thackeray, V.C., K.C.B., late R.E. (Bengal) 401

MILITARY BRIDGES, THE HOLDING POWER OF EARTH IN CONNECTION WITH ANCHORAGES FOR, by Capt. C. E. P. Sankey, R.E. 209

MUSEUM, THE R.E., by Major W. A. Harrison, late R.E. 345

MUSKETRY, THE LATEST DEVELOPMENTS IN, by Brig.-Gen. W. N. Congreve V.C., C.B., M.V.O. 149

Digitized by Google

THE DUAL RÔLE OF R.E. OFFICERS.

By MAJOR A. F. SARGEAUNT, R.E.

BY the dual rôle of R.E. officers, or the two branches into which most of R.E. work is divided, is meant on the one hand all that appertains to the construction and maintenance of buildings, structures, and fortifications, and on the other hand those duties which are enumerated in Field Service and kindred regulations.

There is a tendency amongst some officers to belittle the importance of the work of the branch to which they do not for the time being belong, and to magnify their own particular branch; yet the two branches are interchangeable and an officer who is constructing barracks or fortifications to-day may be commanding an unit in the field to-morrow. It is no doubt difficult for the man who is in his element in working out calculations for a steel roof or designing a ferro-concrete building to sympathize with one whose time is chiefly occupied in training his own men and those of other arms in all that pertains to the art of war in camp and in the field; whilst the keen soldier, who is anxious to show what his own arm can do to assist and co-operate with others in the field is unable to bear with a life which entails much time at an office table and in which there is no soldiering.

It thus comes about that opinions are expressed in which the dual rôle is not recognized; but the fact remains that R.E. officers must be prepared to perform the dual rôle and unless they are so prepared they cannot be considered as thoroughly efficient. Of course there are exceptions to every rule, and some officers may specialize in one particular branch, and may be fortunate enough to be continuously employed in that in which they have specialized; but for the majority it is more a question of being generally useful and efficient than of being a specialist.

As in most cases where there are two well-supported divergent opinions, so in this case the happy mean will be found to lie between the two. If we think for a moment, we shall recollect that nearly every officer looks forward to some day filling the post of C.R.E., and the greater part of a C.R.E.'s work consists in arranging for and superintending building operations. It is therefore of the utmost

Digitized by Google

importance that when he reaches the C.R.E.'s chair, an officer should be *au fait* with the latest ideas in connection with building, *e.g.* the use of new materials and how they affect W.D. work, or the advantages and disadvantages of vulcanite and ruberoid as roof coverings; and further, a C.R.E. with an Army or a Division has in all probability a great deal to do in the matter of constructing bridges, building huts, draining areas, etc., which necessitate a knowledge of the art of the Civil Engineer. We see then the need of all officers keeping in touch with the works or building branch of the Corps.

On the other hand in addition to possessing this knowledge of building a C.R.E. also requires to represent the R.E. in the field with the other arms, and he must be prepared to give advice and instruction in everything which concerns the work of R.E. in the field, and he is the adviser to the G.O.C. as to how the R.E. can be most usefully employed. So, for this reason, R.E. officers must keep in touch with other troops during training and on manœuvres and must be up to date in the latest regulations and ideas on these subjects. These requirements are not peculiar to a C.R.E. who is the C.R.E. of a division as well as the C.R.E. of a district, because all officers are liable to be asked to act as umpires at any time, and opportunities may occur of commanding a mixed force in the field or at a war game, so that R.E. officers ought at all times to be ready to exemplify that they are capable of carrying out these duties as efficiently as an officer of any other branch of the Service.

The question arises how can this double rôle be best filled, that is to say how can a R.E. officer keep abreast of the times as regards field operations and at the same time not get rusty in the matter of bricks and mortar and kindred materials. It is not possible to legislate for officers engaged on special work such as the Ordnance Survey, and staff billets, and these appointments are only of a passing nature and limited to a certain number of years; it therefore follows that the officers to be dealt with fall into two main categories, viz. those employed with field units and those employed with fortress companies or as division officers.

The aim now is to make suggestions by which the individuals in one category may be brought into contact with the individuals in the other category.

The officers with field units will be considered first.

From the beginning of April or May to the end of September the time of officers with field units is occupied with training in one form or another, and there is no time to carry on the work of a division in addition; if the training of a troop or company and the oversight of a division run concurrently, both must suffer and justice cannot be done to either. But at the same time there is ample opportunity

Digitized by Google

during these summer months to train N.C.O.'s in such subjects as road reconnaissance, map reading, small defence, attack, or other schemes, which usually come under the head of winter training; so that those subjects which are comprised in winter training can be carried out during the summer training instead. If this is done, then from the beginning of October to March or April the N.C.O.'s and men can be employed at their trades for at least five days a week either under their own officers or under the D.O., and the drivers and horses can be utilized in carrying materials for repairing roads and parades, etc. Saturday should be reserved for the unit commander to have the whole of the *personnel* of the unit at his disposal for drill or any other purpose that he may think fit. It is not practicable to hand over all the available labour to be used in the division, because in the unit itself there will be considerable work for several tradesmen; wagons have to be painted, carts repaired, pontoons and other technical equipment overhauled, and sufficient men should be put onto this work to get it done as expeditiously as possible.

It is only right that the sapper should have every opportunity of working at his trade through the winter; he enlisted with the idea that he would be employed at his trade, and he becomes a more efficient sapper the more practice he can have; he is also fitting himself for employment when he returns to civil life, and incidentally allows the fulfilment of the Corps Memo. where it is laid down that a man must be employed six months at one trade rate before he can be tested for a higher rate.

No doubt the ideal arrangement is for the men to be employed under their own officers, and this is often feasible, for there are usually certain items awaiting execution and requiring a variety of trades which the C.R.E. can hand over to the unit to carry out, or on a less ambitious plane the O.C. unit may take over the quarterly requisition for one or more barracks and arrange for all the items to be carried out; such work requires organization and forethought if the best use is to be made of men and time. If these suggestions are for some local reasons not practicable, then the *personnel* of the unit must be transferred to the D.O. for him to detail and supervise.

Again, the D.O. will, unless he is unhuman, require leave, and during the period that he is away his place can be taken by an officer from a field unit, who will thus have an excellent opportunity of unearthing buried knowledge and bringing that knowledge more up to date.

Thirdly, there are always questions of enlarging, re-adapting, or building *de novo* in every C.R.E.'s jurisdiction, and although there may be no funds in hand for any particular item yet it is a sound policy to have a cut-and-dried scheme ready to hand. For instance, there may be a proposition to convert a certain building into an

Digitized by Google

Officers' Mess, the alternative being a wholly new building. The D.O. is always a busy man, so here the latent talent in the field units may be advantageously utilized by the C.R.E.; the selected officer can go thoroughly into the alternate schemes, and make his proposals in the form of a report with explanatory sketches. Even though, as already mentioned, there may be no immediate prospect of the work being carried out, yet having a clear and concise report will enhance such a prospect, especially if the question happens to be brought forward for instance during a G.O.C.'s inspection or at a visit by a member of the Army Council.

Much more might be done than is done in officers visiting engineering works in progress. Borough or county surveyors or engineers can name many interesting and instructive works over which they have control. Young officers on a construction tour from Chatham will visit engineering works in the vicinity of garrisons, of which the R.E. officers in those garrisons know nothing; so that here we have an easy and pleasant way for R.E. officers to acquire knowledge of civil engineering, and the cost of the journeys might be borne by the Training Grant or Transport Vote.

There is still one more suggestion, and that is that papers on engineering and building subjects be disseminated much more liberally than they are at present; much may be learnt from the perusal of such papers as *The Building News*, *Engineering Record*, and *Concrete*, and one copy of each could cover a wide area.

If these suggestions, which have been put forward, can be put into practice, the officer with a field unit can no longer complain that he is out of touch with engineering work; and with his own leave, attendance at courses, staff tours, regimental rides, writing essays, etc., he will find that the winter months are profitably and fully occupied.

But how about the Division Officer? How is he to learn to co-operate with infantry, artillery, and cavalry, and to assist them in their particular work? How can he become cognisant of their methods of training, how learn the method of developing an attack? How is he to become acquainted with the organization of his own arm, and to know what it is capable of doing in the field? As with all knowledge, so with this, there is no royal road; it can only be acquired by practice.

Although it is easier to carry out periodical services and other barrack items when the barracks are comparatively empty, yet by pre-arrangement and forethought at the commencement of the financial year it should be possible to have one month, say August or September, when there is a minimum of work in hand, and when the D.O. can be spared. During this pre-arranged month the D.O. should be attached to a field unit during training. He will then

Digitized by Google

learn what technical equipment is carried in the field, what first and second line transport consists of, how camping grounds are prepared for occupation, he will see how the feeding of men and horses is arranged for, he will march and bivouac—in short, many an officer, who is accustomed to the rhythmical routine of a Division Office, and who was under the impression that to belong to a field unit meant to be continually hustled, will learn to delight in the open-air life of the soldier with its concomitant advantages of a healthy appetite and sound sleep.

Officers of fortress companies have to put their men through fieldworks and musketry courses, but they do not as a rule come into contact with other arms during these times. If therefore officers are to be attached to field units it should be at a time when the unit is engaged in brigade, or divisional training, or army manœuvres; a fortnight's training under these conditions is worth several months of training when these conditions are absent. Under these conditions too an unit can usefully employ more than its peace establishment of officers, thus approximating to its war establishment, and such work as reconnaissance for attack or defence can be the better carried out.

Division officers could also be employed as umpires during training and manœuvres, thus relieving regimental officers who could remain with their units. Many officers are taken to act as umpires, who have had no previous experience of such work and their duties are very fully explained in the regulations, so that there is no need to be afraid of courting failure, and as an umpire one gets a wider vision of the trend of events and of the actors than if one is tied to one particular unit, and one hears discussions and criticisms on various points of interest which have arisen during the manœuvre.

Staff tours and War Games, although not to be compared with field training from an instructional standpoint, give an insight into army organizations, road spaces, etc., and give practice in writing orders and in appreciating situations. Tours and war games could be participated in without seriously interfering with the work of a Division Office.

If these suggestions are to be given life it entails co-operation amongst C.R.E.'s. The Training Programmes are published early in the summer, and if the C.R.E.'s in a divisional area could come together when the programme has been published they could formulate a scheme for interchange or attachment of officers as has been suggested, knowing their own requirements and the requirements of the Divisional Headquarters Staff.

Although it may not be possible to intermingle all officers as has been outlined yet it should be possible to do so in the case of the majority of majors and captains, and if it entails putting a junior

Digitized by Google

subaltern in charge of a division whilst the D.O. is training, or of a field unit whilst the O.C. is in charge of a division, then it will be a good experience for these young officers.

These notes do not profess to be exhaustive, nor is it imagined that a cut-and-dried scheme would be applicable to all parts of the country; but the object has rather been to draw attention to the subject so that it may be more generally recognized, that so far as the general work of the R.E. for the Army is concerned, that work is of two kinds, and that a closer association is needed between the officers engaged on these two kinds of work.

Digitized by Google

ECHOES FROM THE ENGINE ROOM.

(*Concluded*).

By "INSPECTOR."

ECHO NO. 18.

PUMP SPEEDS.

Some general observations upon choice of plant are made later on, it will therefore suffice to remark here that although it may be possible to get the desired output from a small pump driven unduly fast, such a pump is less likely to give reliable service than one more appropriately proportioned to the work to be done. The deduction from this is that, in selecting a pump, it is insufficient to consider only the head concerned and the gallons per minute, especially so in the case of competitive tenders. It is desirable therefore, in the case of reciprocating pumps, to decide upon some limiting speed for the pump plunger, ram, or piston. Manufacturers' lists are apt to be somewhat misleading in this respect as some makers adopt a far more liberal rating than others. Although therefore this point can best be decided by experience, some general remarks may be of assistance. To avoid misunderstanding, by "pump speed," or simply "speed," is here meant the mean speed in feet per minute of the pump plunger, ram, piston, or bucket.

In the case of steam pumps or pumping engines it is the pump end that limits the permissible speed. The longer the stroke of the pump the higher may the speed be. The higher the head worked against the slower must the pump be run. The more uniform the flow of water from the pump the faster may the pump be worked without causing undue "hammer" or other discomforts. For instance a 3-throw pump can work satisfactorily at a higher speed than a single ram pump. Again, the permissible speed will depend somewhat upon the design of the pump valves; their size and lift and number. The speed is moreover governed more or less by the general design of the pump. For example it is permissible to run a direct acting pump faster than one of the same size operated by long rods *e.g.* a well pump. And finally the speed is influenced by the air vessels on the pump.

If one considers the results of actual practice and summarizes the deductions that can legitimately be made from the published catalogues of leading manufacturers, it will be found, in spite of all these varying factors, that some fairly definite figures for speed can be arrived at.

Digitized by Google

It is not desirable to run boiler feed pumps of the "donkey" type too slowly if advantage is to be derived from the flywheel; but for continuous working it may be preferable to sacrifice the flywheel effect to some extent in order to avoid excessive wear and secure reliability. Having regard to these considerations the following limits of speeds appear to be appropriate for this class of pump:—

For a stroke of	2"	... ...	40 f.p.m.
,,	4"	... ...	70 ,,
,,	6"	... ...	80 ,,

For flywheel pumps of the "Manchester," "Cameron" and "Colchester" types and for direct acting flywheel pumps generally the limits given above may be taken as a guide for the smaller sizes. For the larger sizes the corresponding limits would be

For a stroke of	9"	... ...	100 f.p.m.
,,	12"	... ...	120 ,,
,,	18"	... ...	180 ,,

These figures may be compared with the speeds for flywheel pumping engines given in Table IV.

For power pumps attention is directed to Table I. The speeds there given are deduced from a catalogue referring to pumps for mining and general purposes, they are considerably lower than the speeds deducible from some other makers' lists for corresponding pumps, but are not unduly low for permanent requirements entailing long hours of work. The details are given partly to illustrate the reduction of speed as the head is increased. Table II. gives the speeds deduced from another maker's list, and these form a useful guide for all ordinary purposes.

TABLE I.

Pump Speeds. Three Throw Power Pumps.

Stroke of Pump. (Inches).	Head. (Feet).	Speed (F.P.M.).	
		Standard.	Max.
6	1800	—	45
6	1200	—	50
6	600	60	80
6	200	70	85
12	1800	—	60
12	1200	—	70
12	600	70	100
12	200	80	100
15	1800	—	62·5
15	1200	—	75
15	600	75	100
15	200	75	100

TABLE II.

Pump Speeds. Three Throw Power Pumps.

Stroke of Pump. (Inches).	Head.	Speed (F.P.M.). Standard.
6	Up to 225 lb.	50
8	,,	60
10	,,	70
12	,,	80
15	,,	100
18	,,	105
4	Up to 100 lb.	67
6	,,	75
8	,,	80
12	,,	100
15	,,	105

Digitized by Google

For well pumps the speeds given in Table II. may be divided by 2 if the pump rods do not exceed 100′ in length. With longer rods the speed should be still further reduced.

The leading makes of single cylinder, or "Simplex," straight line pumps for boiler feeding usually have a stroke which is long in comparison to the diameter of the water piston, and in these pumps the speed is low relatively to that of pumps generally. The following figures are deduced from the catalogue of one of the leading makers of this type of pump :—

Stroke	6″	...	...	...	...	22 f.p.m.
,,	12″	...	...	...	...	30 ,,
,,	18″	...	...	...	...	36 ,,
,,	24″	...	...	..	...	48 ,,

These figures are also applicable to tandem compound pumps of this type, and represent the maximum speeds at which these pumps should be run for continuous working for boiler feeding.

Double cylinder, or "duplex," straight line pumps may be run faster than those of the "simplex" type because of the more regular flow of water from them. Some makers give the list rating of such pumps upon a basis of 75, or even 100, feet p.m. but a consideration of the factors governing the speed of a pump suggests that such a basis is wrong. Table III. gives results deduced from the catalogue of one of the leading makers of duplex pumps; these figures may be compared with the speeds given in Table IV. and may be relied upon as representing good practice for continuous work.

TABLE III.

Speed of Straight Line, Duplex Pumps.

Stroke of Pump. (Inches).	Head.	Speed (F.P.M.).		Remarks.
		Standard.	Max.	
3	Up to 160 lb.	25	62·5	Suitable for piston and plunger pumps. For ram pumps working at higher heads lower speeds are preferable.
6	,,	50	75	
10	,,	62·5	104	
15		62·5	125	
4	Above 300 lb.	16·75	33·5	Externally packed ram pumps. Boiler pumps.
6	,,	37·5	62·5	
10	,,	41·5	75	Externally packed ram pumps. Mining type.
15	,,	50	100	
18	,,	60	110	
4	Up to 8000 lb.	20	33	Hydraulic pressure pumps of the externally packed ram type.
6	,,	25	45	
10	,,	33	62·5	
15	,,	37·5	80	

Digitized by Google

Table IV. gives results from actual practice or from data received in connection with offers to meet definitely specified conditions. To save trouble in reproducing this table, figures for steam consumption are also included therein—these are referred to again further on.

TABLE IV.—PART I.

Speeds, P.H.P., and Steam Consumption of Flywheel Pumping Engines.

Reference.	Pumping Engine (Inches).	Boiler Pressure (lb.).	Head (Ft.).	P.H.P.	Speed (F.P.M.). Normal.	Speed (F.P.M.). Max.	Steam Feed Coal per P.H.P. Hr. (lb.).	Remarks.
A	$\frac{7\frac{1}{2} \times 13}{7\frac{1}{2}} \times 12$ ...	110 S.	145	7·5	90	120	29 S.	Plunger. Tandem Comp. C.
B	$\frac{8\frac{1}{4} \times 13}{3\frac{5}{8}} \times 12$ ...	120	1450	13·5	90	150	32 S.	Ram. Side by Side Comp. N.C.
C								
D	$\frac{9 \times 14\frac{1}{2}}{2\frac{5}{16} \times 3\frac{1}{8}} \times 20$ ...	140	1540	22·1	127	150	35·2 S. 6·22 C.	Differential Ram. Cross Comp. N.C.
E	$\frac{10 \times 22}{6} \times 18$ ...	120 S.	400	42·2	145	175	22 S.	Piston. Cross Comp. C.
F	$\frac{12 \times 26}{7\frac{1}{2}} \times 24$ ...	120 S.	400	84·4	180	220	20 S.	Piston. Cross Comp. C.
G	$\frac{10 \times 15 \times 26}{3\frac{1}{2} \times 5} \times 24$	125 S.	1142	46·6	150	180	18·5 S. 21·0 F. 3·29 C.	Differential Ram. Side by Side Triple. C.
H	$\frac{15 \times 25 \times 40}{13\frac{1}{2}} \times 36$	140	287	167	—	287	13·05 S.	Ram. Marine Type Triple. C.
I	$\frac{23 \times 43 \times 64}{12} \times 36$	200 S.	930	410	198	240	11·42 S.	Ram. Marine Type Triple. C.

Digitized by Google

TABLE IV.—Part II.

Speeds, P.H.P., and Steam Consumptions of Duplex Straight Line Pumping Engines.

Reference.	Pumping Engine (Inches).	Boiler Pressure (lb.).	Head (Ft.).	P.H.P.	Speed (F.P.M.). Normal.	Speed (F.P.M.). Max.	Steam Feed Coal per P.H.P. Hr. (lb.).	Remarks.
P	$\frac{6}{5\frac{3}{4}} \times 6$	80	97	3·18	50	55	97 F. 19·7 C.	Piston. N.C.
Q	$\frac{5\frac{1}{4} \times 7\frac{1}{2}}{2\frac{3}{4}} \times 6$ ...	80	375	2·9	50	55	19·9 C.	Ram. N.C.
R	$\frac{6 \times 10}{3} \times 10$... ...	90	770	13·39	85	100	40·75 S. 56·1 F. 7·43 C.	Ram. C.
S	$\frac{5\frac{1}{4} \times 8 \times 14}{7\frac{3}{8}} \times 10$.	110 S.	140 105	15·25 8·66	67	100	42 S. 55 S.	Plunger. C.
T	$\frac{5\frac{1}{4} \times 8 \times 14}{3\frac{1}{8}} \times 10$ ..	140 S.	890 1490	16·1 21·45	83 67	92 75	30·8 S. 31·25 S.	Ram. C.
U	$\frac{5 \times 8 \times 13}{7} \times 15$.	110	182	25·5	125	150	18·35 S. 28·3 F. 5·21 C.	Plunger. C.
V	$\frac{6 \times 9 \times 16}{9\frac{1}{4}} \times 15$ ...	110 S.	60	9·41	100	125	44·4 S. 90·6 F. 12·7 C.	Plunger. C.
W	$\frac{10 \times 16}{12} \times 12$ ...	90	120	28·2	80	100	56·4 F. 8·05 C.	Plunger. N.C.
X	$\frac{8\frac{1}{2} \times 13 \times 21\frac{1}{2}}{9} \times 18$	110	388	84·6	150	165	19·68 S. 26·6 F. 3·75 W.	Plunger. C

It is not intended to suggest that the maximum speeds given above never are and cannot be exceeded. For purely temporary work those speeds should certainly be increased in order to save the cost of a needlessly durable outfit. On the other hand the governing conditions for a permanent job may render it necessary to run the pump concerned appreciably below the maximum speed given in the tables. In short, although the tables are undoubtedly useful as a general guide, they should not be blindly followed.

Digitized by Google

ECHO NO. 19.

RELATIVE DIMENSIONS OF STEAM END AND WATER END.

In the pumps herein discussed the steam end is always double acting, but the water end may be either single acting or double acting.

If the push and pull of the steam end is called "Effort," and the opposition offered by the water end "Resistance," then the "Fraction" $\frac{\text{Effort}}{\text{Resistance}}$ will always be greater than unity.

If the steam pressure available and the total head are known then it might be reasonable to expect that the above fraction would have some fairly definite value. If the steam end is compound the situation becomes somewhat more complicated.

There is always the friction in the pump to be allowed for, and in the case of a pump used for feeding the boiler from which it is supplied with steam, allowances may also have to be made for (i.) loss of steam pressure between boiler and pump, (ii.) resistance offered by feed check valve, feed heater, water meter, economizer, etc.

Effort and Resistance will depend upon the area of the steam end and water end respectively, and the value of the "Fraction" will therefore be deduced generally from the square of the diameters of the two ends. In the case of compound pumps each cylinder may be assumed to give half the total effort and the "fraction" will refer to the relationship between the H.P. cylinder and the water end.

The question as to the horse-power of a pump with given dimensions, supplied with steam of a definite pressure, and run at a certain piston speed, is discussed at some length in Echo No. 20. For present purposes it is assumed that Effort = pressure at stop valve $\times$ (diam.)^2 of steam end, and Resistance = head $\times$ (diam.)^2 of water end. If the relative dimensions of standard sizes of steam pumps are compared on this basis it is found that the "fraction" has the valves shown in Table V. for different classes of pumps.

The meaning of the "fraction" can best be illustrated by quoting a few examples from which the general results have been deduced.

Example 1.—Straight line. Both ends D.A. Single cylinder. Duplex. For boiler feeding. Size, 9″ steam, 5″ water.

$$\text{Fraction} = \frac{9 \times 9 \times \text{steam pressure}}{5 \times 5 \times \text{steam pressure}} = 3{\cdot}24.$$

Example 2.—As for Example 1 but for water supply. Steam pressure 50 lb.; head 300′. Size, 10″ steam, 5″ water.

$$\text{Fraction} = \frac{10 \times 10 \times 50 \times 2{\cdot}31}{5 \times 5 \times 300} = 1{\cdot}54.$$

Were this pump used for boiler feeding the corresponding fraction would be "4".

Digitized by Google

Table V.

Relative Dimensions of Steam and Water Ends.

Type of Pump.	Value of "Fraction."				Remarks.
	Boiler Feeding.		Water Supply.		
	Limits.	Average.	Limits.	Average.	
Straight Line.					
Both ends D.A.—					
Single Cylinder ...					
"Duplex"	2 to 6	2·75	—	1·5	Notes (*a*) and (*b*).
"Simplex"	1·75 to 2·5	2	—	1·5	
Tandem Compound—					
"Duplex"	1 to 1·75	1·25	1 to 1·125	1·1	Note (*c*).
"Simplex"	1·25 to 1·5	1·35	—	—	
Flywheel.					
Steam D.A. Water S.A.—					
Single cylinder ...	2 to 4	2·5	—	1·0	Note (*d*).
Two cylinders, side by side.	1·5 to 4	2·0	—	1·0	Note (*e*).
Compound, side by side	1 to 2·25	1·5	1 to 1·3	1·125	Note (*f*).
Both ends D.A.—					
Single cylinder ...	2·5 to 4	2·5	—	1·5	Notes (*d*) and (*e*).
Two cylinder ...	2·5 to 4	2·5	—	1·5	Note (*g*).
Compound	No data available.				

All above pumps are non-condensing.

NOTES ON TABLE V.

(*a*). The smaller the pump the higher the value of the fraction. This applies in every case.

(*b*). If the steam end directly operates the water end through rods, as may be necessary when the pump end is placed some way down a well, the fraction 1·5 becomes 1·7.

(*c*). In the case of tandem, and other compound pumps each cylinder does about half the work.

(*d*). The fraction has a high value for boiler feeding as it may be necessary to run the pump so slowly that the flywheel effect is negligible. For this reason the fraction has the same value even when the water end is double acting.

(*e*). This type of pump is nearly equivalent to a single-cylinder pump with both ends double acting, hence the fractions have the same values as in that case. Somewhat smaller values would, however, seem to be permissible, especially so in comparison with the figures for compound pumps.

(*f*). Although the flywheel effect may be small, one cylinder nevertheless assists the other. The same applies in the case of twin-cylinder pumps.

(*g*). This case is more strictly similar to a single-cylinder pump with both ends double acting.

General Note.—S.A., and D.A., signify "single acting" and "double acting" respectively.

Boiler feeding figures refer to cases where a pump supplies with water the boiler by which it is supplied with steam. It is assumed that the pressure per square inch on the steam end is the same as that upon the water end.

Water supply figures are based upon assumed conditions of a definite effective steam pressure in the steam end and a definite head against the pump end.

Digitized by Google

Example 3.—Flywheel. Steam end S.A.; water end D.A. Compound. Two rams. Boiler feeding. Size, 6″ and 10″ steam, 5″ water.

$$\text{Fraction} = \frac{6 \times 6}{5 \times 5} = 1{\cdot}44.$$

Example 4.—As for Example 3 but for water supply. Steam 60 lb.; head 160′. Size, 12″ and 16″ steam, 10″ water.

$$\text{Fraction} = \frac{12 \times 12 \times 60 \times 2{\cdot}31}{10 \times 10 \times 160} = 1{\cdot}25.$$

Were this pump used for boiler feeding the fraction would be 1·44 as in Example 3.

ECHO NO. 20.

SELECTION OF PUMP FOR GIVEN DUTY.

For temporary purposes it is not worth going to the expense of complications if a simple pump can be obtained to do the necessary work. Economy in first cost is more important than economical operation, and hence, provided reliability is not unduly sacrificed, a single or double cylinder non-condensing pump, to be run at its maximum speed, is to be preferred for such work. The requirements to be met may however be so little known beforehand that it may be necessary to allow a considerable margin in the size of pump selected.

Similar arguments apply generally to cases where the pump is only required occasionally, or if the pump is only run for two or three hours a day. Under such conditions although it may be gratifying to have a small steam consumption, such as would be obtainable with a high class pumping engine, from a business point of view the capital cost must not be overlooked. Exceptions may however arise which will call for some modification of this *e.g.* fuel may be very costly.

The more permanent the requirement, the higher the cost of fuel, and the longer the hours of daily pumping, the more justifiable is it to employ two stage or three stage expansion, and surface condensing; but it should be remembered that it is necessary to engage more highly paid labour for relatively complicated pumping plant in order to insure that the plant is worked to the best advantage.

In the case of a permanent military water supply scheme the requirements are probably known fairly definitely when the plant is installed, and although some allowance should be made for unforeseen contingencies it is not economical to put in plant that is needlessly big for the job. Recent water supply schemes for Indian cantonments have been based upon the assumption that the daily supply should be pumped in 8 hours; this allows an ample margin to meet possible increases in the daily consumption of water, always supposing that there is a liberal supply of water to be pumped. It may not be feasible to greatly accelerate the speed of the pump, as the correspondingly greater output might increase the "head" beyond that for

Digitized by Google

which the pump is suitable; moreover, by assumption, the pump should not be so much too big for the original requirements as to permit of any very large increase in its power in this way. The pump can however be run for longer hours daily, the pump house staff being added to if necessary to meet this. In what follows permanent requirements will alone be considered.

In the case of deep-well pumps the engine generally drives the crankshaft of the well gear by belt or through gearing or by a combination of belt and gearing and the engine is thus fairly comparable with any other engine used for driving ordinary machinery, as its speed is but indirectly governed by the requirements of the pump. The same remark applies to power pumps. But as regards direct-acting pumps, with which this Echo is more intimately concerned, the conditions are somewhat different in that the permissible speed of the pumping engine is limited by the water end.

Although single cylinder non-condensing pumps are made in sizes up to 50 pump horse-power (P.H.P.), and more, for 50 lb. steam, such a pump would be quite unsuitable for a permanent scheme. Per contra, a duplex, triple expansion, condensing pumping engine does not accord with "Inspector's" view as to what is suitable for an output of 10 P.H.P. or less. Doubtless the personal opinion of the "consulting engineer" is a big factor in the selection of a pump for a given duty, and therefore the remarks that follow can at best only be taken as suggestions.

For pumping plant (for water supply purposes—not boiler feeding) there is always ample water available for condensing, if, as is commonly the case the pumped water is used for that purpose, hence for 10 P.H.P. and upwards the engine may advantageously be made surface condensing; below this size condensing is hardly justifiable as a general rule, especially if the conditions permit of utilizing the exhaust steam in a feed water heater or water softening plant.

Compound pumps are made in quite small sizes, for one P.H.P. or less, but unless fuel is expensive a compound pump seems scarcely permissible for anything less than 5 P.H.P.

A triple expansion pump may be used for 25 P.H.P. and upwards, but for smaller sizes a compound pump is more appropriate, indeed, having regard to first cost, simplicity of operation, and all the other factors applicable to normal conditions it is doubtful if this limit should not be doubled unless fuel is very costly or the hours of pumping almost continuous.

For single stage expansion a steam pressure of from 50 to 80 lb. per square inch by gauge at the engine stop valve should be aimed at. For two-stage expansion the pressure may be 80 to 120 lb., and for three-stage expansion the pressure may be 100 lb. and upwards.

These are the general suggestions, but there are several modifying

Digitized by Google

factors. For instance the plant, although permanent, may be only worked occasionally, or intermittently, and therefore the above limits for compound or triple expansion plant may require extending. Or, for the same reasons, in order to reduce the capital cost it may be preferable to get the requisite effort by leaving out the condenser and working at a higher initial pressure.

These suggestions for permanent requirements may be conveniently put in a tabular form :—

Single Cylinder.—Up to a maximum of 10 P.H.P. Boiler pressures up to 100 lb. Always non-condensing.

Compound.—From 5 P.H.P. up to 25 P.H.P. generally, but from 2·5 to 50 P.H.P. to meet special conditions. Boiler pressures from 80 lb. upwards. Condensing above 10 P.H.P. always, never below 5 P.H.P.

Triple Expansion.—From 25 P.H.P. upwards. Boiler pressures from 100 lb. upwards. Always condensing.

These are the suggested limits for flywheel pumps. Since a straight line pump is less able to use the steam expansively it would be justifiable to instal a triple expansion pump of that type for sizes below 25 P.H.P.

Echo No. 10 may be referred to as to choice of type in the case of Power Pumps, and Echo No. 18 for a guide as to piston speeds.

As regards the type of pump end, the relative merits of piston, plunger, and ram have been already discussed.

Although hydraulic pressure pumps are made to work against what is equivalent to very high heads, it seems usual, when considerable quantities of water have to be dealt with, not to exceed 2,000′ in a single lift.

Even though the type of pump may have been decided upon, there is still an important point to be settled, namely, the number of pumps to be installed to deal with the supply required. On the grounds that reliability of service is supremely important, it is sometimes contended that it is better to provide three pumps than two, even though with three pumps two would normally work simultaneously, whereas with two (larger) pumps each would be able to give the necessary output alone. While it may be admitted that this view deserves consideration when the size of the plant is based upon eight hours' pumping daily, it is contended that two pumps, *i.e.* one in work and one spare, is the preferable arrangement in nearly every case. Two sets of plant, each of a size which, for purposes of comparison may be called "unity," will cost less than three similar sets each of "half" size. One "unity" set will be more economical in working than two "half" size sets, and unless the conditions are very abnormal the two sets give a reasonably sufficient margin of spare plant.

Digitized by Google

Although the reader of these notes may have to specify the boiler pressure intended, or available, and also the "speed" permissible, type of steam end and of pump end, it will scarcely be necessary for him to lay down the sizes of cylinders and length of stroke. On the other hand it would often be useful for him to know approximately whether the plant offered is of economical size for the work proposed.

It is not difficult to work out the indicated horse-power (I.H.P.) of a steam engine from indicator diagrams taken from it, and, from a study of the diagrams a fairly good idea can be obtained as to whether the engine is working up to its maximum output or not. It is less easy to say beforehand what the maximum output of an engine would be at a definite speed and with a certain initial pressure.

The formula applicable to the indicator diagram is

$$\frac{P \times L \times A \times N}{33{,}000} = \text{I.H.P.}$$

In this formula the only variables, for a particular engine, are "P" and "N" *i.e.* the M.E.P. (mean effective pressure) and the number of strokes per minute. Applying this formula in a different way the M.E.P. can be deduced for an observed brake horse-power (B.H.P.) at a particular speed *i.e.*

$$P = \frac{33{,}000 \times \text{B.H.P.}}{L \times A \times N},$$

and for purposes of comparison the piston speed, in feet per minute, can be substituted for L × N. If "B.H.P." is taken as the maximum output at which it is desirable to work the engine in practice, it is found that the value of "P" depends upon (i.) the initial pressure (*ii.*) whether the engine is worked condensing or non-condensing and (*iii.*) whether the engine is single cylinder, compound, or triple expansion; but for any given set of conditions "P" is practically constant. If in addition to this the piston speed is constant, the only variable in the above formula is "A," *i.e.* the area of the piston, and since "A" depends upon the square of the diameter of the cylinder, we may write

$$\frac{P \times L \times A \times N}{33{,}000} = \text{B.H.P.} = d^2 \times F,$$

where "F" is a factor depending, for a particular piston speed, upon the three conditions enumerated above, and "*d*" is the diameter of the cylinder in inches. (The L.P. cylinder in compound and triple expansion engines).

In a compound engine it may be assumed that each cylinder does half the work. This is true if the valves are properly set and if the engine is fairly well loaded. Similarly in a triple expansion engine each cylinder does one-third of the work. To apply the above deductions as to M.E.P. and the factor "F" to compound and triple expansion engines the L.P. cylinder is alone considered in each case.

Digitized by Google

In order to arrive at a suitable value for "F" as regards the pumping engines dealt with in this Echo a piston speed of 120 f.p.m. is assumed. For any other piston speed of "X" f.p.m. divide by 120 and multiply by "X" to arrive at the maximum B.H.P. The results arrived at by using the formula $d^2 \times F$ may, in the case of direct acting pumping engines, be taken to represent the maximum pump horse-power (P.H.P.) of the engine concerned. By "maximum" is meant the highest output which should be continuously demanded from the pumping engine at the speed concerned; not the highest possible output attainable. It may be permissible to exceed the maximum arrived at by use of the formula given here, with the stated value of "F" for any particular set of conditions, either by increase of speed up to the limit for which the engine is suitable, or by increasing the initial pressure (and therefore) the M.E.P.; but for *economical* working it is preferable to work the engine somewhat below the power given by the formula. This economical power is lower, relatively, for condensing engines than for non-condensing, but leaving this refinement out of consideration the economical power may be taken as 70 per cent. of the maximum power deduced from the use of the values of "F" given below.

Tabulating average values for M.E.P. and "F" deduced from various sources the following figures are obtained.

Non-Condensing.

Pressure at engine stop valve. Lb.	50	60	80	100	120	140
Single cylinder.						
M.E.P.	25	30	40	51	—	—
F.	·07	·085	·115	·145	—	—
Compound.						
M.E.P.	—	16	21	27	32	37
F.	—	·045	·06	·075	·09	·105

Condensing.

Pressure at engine stop valve. Lb.	60	80	100	120	140	160	180
Single cylinder.							
M.E.P.	42	47	60	—	—	—	—
F.	·12	·135	·17	—	—	—	—
Compound.							
M.E.P.	—	27	32	40	46		
F.	—	·075	·09	·115	·13	·145	·165
Triple Expansion.							
M.E.P.	—	—	24·5	26·5	28	30	31·5
F.	—	—	·07	·075	·08	·085	·09

Digitized by Google

The figures given above are applicable for ordinary ratios between the areas of H.P.; I.P.; and L.P. cylinders. Normally the relative areas of the cylinders lie between the following limits, viz.:—For compound, non-condensing, H.P.:L.P.::1:2 or 1:3. For compound condensing, H.P.:L.P.::1:3 or 1:4. For triple expansion, condensing, H.P.:I.P.:L.P.::1:2·5:5 or 1:3·5:9.

The values for "F" are deduced almost directly from the corresponding values for M.E.P. It will be noted that in every case the M.E.P. is considerably below the initial pressure and although in practice cut-off would not occur so early in the stroke as the low value of the M.E.P. would suggest nevertheless it must take place considerably before the end of the stroke in order that the given values for M.E.P. shall result.

These figures may be taken as reasonably accurate for single cylinder and compound engines; they may be less reliable for triple expansion engines as the data available to "Inspector" for deducing average results have been somewhat scanty. To avoid misunderstanding it must be remembered that the values for M.E.P. apply in any case, but the values for "F" only refer to a piston speed of 120 f.p.m.; in both cases the figures only apply to the L.P. cylinder in compound and triple expansion engines.

The tabulated figures refer more correctly to those pumping engines in which a comparatively early cut-off can be advantageously used, *e.g.* flywheel engines. The figures are less appropriate to straight line engines, since this type, as has been already pointed out, is less able to use the steam expansively, especially so as regards single cylinder and compound engines; hence for these engines the P.H.P. resulting from the use of the figures in question represents the economical rather than the maximum horse-power.

Finally, in the case of condensing engines, the figures apply to machinery at sea level; at considerable elevations above sea level some reduction will occur in the vacuum attainable. However for the purposes of this Echo any correction on this account may be ignored because after all the values of "F" will only give an approximate test as to the output of the pumping engine concerned.

With the above values of "F" as a basis one may consider how far the pumping engines given in Table IV. are suitable for the work for which they have been supplied. This is dealt with in Echo No. 22 but it is to be distinctly noted that so far as is known, the contractors concerned were alone responsible for all the details connected with the engines in question. Whoever acted as "consulting engineer" only enumerated the conditions to be fulfilled as to gallons per minute and head. In but few cases were the engines supplied under any guarantee as to steam consumption.

Digitized by Google

ECHO NO. 21.

STEAM CONSUMPTION.

Table IV. gives the results of a number of actual tests upon different sizes of pumping engines and contains figures for steam consumption and fuel consumption per pump-horse-power-hour which may serve as a guide for estimating the performances of engines of similar sizes and types. Of course in everyday working it is only to be expected that the results will be appreciably worse than those obtained on test, apart from the losses due to raising steam, warming up, etc.

The following figures, expressed in steam consumption per pump-horse-power-hour, may be taken as a general guide, but in the case of boiler feed pumps there are many occasions when the actual consumptions are not less than double the amount shown.

Injectors	800 lb. and upwards.
Pulsometer type pump	500 lb. and upwards.

Boiler Feed Pumps. *Straight Line.*	*Non-condensing.*
Single cylinder, duplex	120 lb. or more.
Compound, duplex	80 lb. or more.
Single cylinder long stroke simplex ...	100 lb. or less.
Compound, simplex	50 lb. or less.

	Pumping Engines.	*Condensing.*
Compound.	10 P.H.P.	35 to 40 lb.
„	15 P.H.P.	30 to 35 lb.
„	25 P.H.P.	25 to 30 lb.
Triple.	Above 25 P.H.P.... ...	25 lb. and less, according to size.

The steam consumption of flywheel "pumps" may be taken as the same as the corresponding figures for duplex and simplex pumps depending respectively, upon whether they are run slowly, or at a speed when the flywheel is effective.

Whereas flywheel pumping engines may be expected to give results approaching the lower limit shown the figures for corresponding straight line engines would be nearer the higher limit.

The above figures refer to ordinary steam pressures without superheat. They would be reduced from 10 to 20 per cent. in the case of pumping engines with 100° Fah. of superheat at the engine stop valve.

Digitized by Google

ECHO NO. 22.

CRITICISMS ON PUMPING ENGINES REFERRED TO IN TABLE IV.

Notes on Table.—(*a*). In the fractions under the heading "Pumping Engine" the numerator denotes the sizes of the steam cylinders, and the denominator the size of the pump end; the dimension on the right gives the nominal length of stroke. Thus $\frac{5\times8\times13}{7}\times15$ signifies a triple expansion engine with cylinders 5", 8", and 13" in diameter, with a pump end 7" in diameter, the stroke of all being 15".

(*b*). The letter "S" added after the boiler pressure means that the boilers are fitted with superheaters.

(*c*). The "head" given is that recorded during a test unless otherwise stated elsewhere.

(*d*). The speeds shown are those actually worked to or are the makers' rated speeds as the case may be.

(*e*). P.H.P. is calculated from the theoretical displacement of the pump during the test and from the observed head; no allowance made for slip. In no case did the slip exceed 6 per cent. of the theoretical displacement where it was possible to check it. Head was checked by an engine indicator where possible, but generally speaking it was taken directly from the pressure gauge on the rising main.

(*f*). In the last column but one the figures given show the results obtained by "Inspector" on test, unless otherwise stated. The letters "S," "F," "C," and "W," denoting cylinder steam (*i.e.* discharge from air pump), feed, coal or wood, respectively.

(*g*). The type of pump end is given under the column of "Remarks." The letters C, and N.C., signify that the pump was condensing or non-condensing. Condensers in question were all of the surface type.

(*h*). The efficiencies given in the notes below have been deduced from indicator diagrams and represent the values of the fraction $\frac{\text{P.H.P.}}{\text{I.H.P.}}$

(*i*). The evaporations recorded are deduced from the actual figures for feed and coal corrected to the standard "from and at 212° F."

Part I. of Table IV. refers to flywheel pumping engines.

Pump A.—Compound, condensing.

Not yet erected, but supplied to deliver 170 g.p.m. against a total head of 145′ with 90 lb. stop valve pressure, at a piston speed not exceeding 100 f.p.m.

Guarantee is 29 lb. steam per p.h.p. hour, and output is based on a piston speed of 90 f.p.m.

The specified output is equivalent to $\frac{1{,}700\times145}{33{,}000}=7{\cdot}5$ P.H.P.

H.P. by formula at 90 lb. pressure and 90 f.p.m. is

$$13^2\times{\cdot}0825\times\tfrac{90}{120}=10{\cdot}45 \text{ P.H.P.}$$

Digitized by Google

From this the economical output may be deduced as

$$10{\cdot}45 \times {\cdot}7 = 7{\cdot}32 \text{ P.H.P. nearly.}$$

Deduction.—Under the limitations as specified the pump should be suitable for the job. A piston speed of 90 f.p.m. is appropriate for normal working in this case with a 12″ stroke.

It would doubtless be possible to run the pump up to 120 f.p.m. on emergency, at which speed the output by formula would be 15 P.H.P.

Note.—Since erection a preliminary test gave less than 29 lb. steam per P.H.P. hour. Engine new and working stiff.

Pump B was offered as an alternative to Pump T in Part II. and is dealt with later.

Pump D.—Compound, non-condensing. Cylinders jacketed.

Duty for which supplied :—2,500 g.p. hour against 1,550′ head, at a normal speed of 38 r.p.m., maximum speed 45 r.p.m.

Guarantee was to deliver 1,000 gallons on a consumption of 216 lb. steam (or "feed"—doubtful which was intended). The H.P. is $\frac{25{,}000 \times 1{,}550}{60 \times 33{,}000} = 19{\cdot}6$ P.H.P. It would require $\frac{1000}{2500}$ of an hour to deliver 1,000 gallons and the corresponding p.h.p. hours is $\frac{2}{5} \times 19{\cdot}6$. The guarantee therefore corresponds to $\frac{216 \times 5}{2 \times 19{\cdot}6} = 27{\cdot}7$ lb. of steam (or feed) per p.h.p. hour. The best result obtained on test has been 35·2 lb. feed per p.h.p. hour. A good result for a N.C. pumping engine of this size.

Duty for which actually used corresponds closely to the above.

Taking a stop valve pressure of 120 lb. the maximum horse-power by formula at a piston speed of 127 f.p.m. (corresponding to 38 r.p.m.) is

$$(14{\cdot}5)^2 \times {\cdot}115 \times \tfrac{127}{120} = 25{\cdot}65 \text{ P.H.P.}$$

The corresponding economical output is nearly 18 P.H.P.

Deduction.—The pump is worked near its limit. In practice it is found that the boiler pressure must be kept up to 125 lb. or over. Under normal circumstances this size of pump should be condensing, and even though this particular pump is but little worked for the six winter months, condensing would have been preferable in this case as fuel is costly.

Pump E.—Compound, condensing. Re-heater between H.P. and L.P. cylinders ; no jackets.

An offer for a pump to deliver 500,000 gallons per 24 hours against a head of 400′ upon a steam consumption of 22 lb. steam per p.h.p.h. with boiler pressure of 120 lb. and 120° Fah. superheat at boiler. Normal speed deduced from output ; maximum speed, estimated.

H.P. by formula with a stop valve pressure of 100 lb. and a speed of 145 f.p.m.

$$22^2 \times {\cdot}09 \times \tfrac{145}{120} = 52{\cdot}6 \text{ P.H.P.}$$

Deduction.—Suitable.

Digitized by Google

Pump F.—Compound, condensing. Re-heater between H.P. and L.P. cylinders; no jackets.

As for Pump E but for 1,000,000 gallons per 24 hours, and 20 lb. steam per p.h.p. hour.

H.P. as above, for speed of 180 f.p.m. would be

$$26^2 \times \cdot 09 \times \tfrac{180}{120} = 91 \cdot 2 \text{ P.H.P.}$$

Deduction.—Suitable.

Pump G.—Triple, condensing. Cylinders jacketed.

Duty for which supplied, 7,500 g.p.h. against 1,142′ at 38 r.p.m. with maximum speed of 45 r.p.m. Guarantee 22 lb. steam (or feed).

Stop valve pressure is 120 lb. H.P. by formula is

$$26^2 \times \cdot 075 \times \tfrac{150}{120} = 63 \cdot 5 \text{ P.H.P.}$$

Economical loading is $63 \cdot 5 \times \cdot 7 = 44 \cdot 4$ P.H.P.

Deduction.—Appropriate to the job, and an economical engine in steam.

Pump H.—Triple, condensing, inverted marine type.

Engine supplied to Leeds, England. Data abstracted from published reports.

Pump I.—Generally similar to Pump H.

Engine supplied to Rand Water Board. Data abstracted from published reports. The engine is classed as "slow-speed."

Part II. of Table IV. refers to straight-line pumping engines, and since, in every case, water is within suction distance of the pump room floor "Inspector" considers that a flywheel pump would have been preferable in every instance. All pumps are duplex and therefore the formula becomes $\text{P.H.P.} = d^2 \times \text{F} \times 2$.

Pump P.—An ordinary "trade" pump. Double cylinder, non-condensing.

Supplied to deliver 6,500 g.p.h. against 80′.

Taking a stop valve pressure of 70 lb. and interpolating a value for "F," the H.P. at 50 f.p.m. is

$$6^2 \times \cdot 1 \times \tfrac{150}{120} \times 2 = 3 \text{ P.H.P.}$$

Deduction.—Suitable, but as will be seen the consumption of feed per p.h.p. hour is very high, as is only to be expected from a small pump of this type.

Pump Q.—Compound non-condensing. Duplex.

Duty for which used entails an output of about 3 P.H.P. at a piston speed of 50 f.p.m.

Take stop valve pressure of 70 lb. then by formula

$$(7 \cdot 5)^2 \times \cdot 75 \times \tfrac{150}{120} \times 2 = 2 \cdot 34 \text{ P.H.P.}$$

Digitized by Google

Deduction.—The pump is fully loaded when stop valve pressure is only 70 lb. Although fuel is costly it is questionable if compounding is quite justifiable for such a small pump. Allowing an evaporation of 4 lb. steam per lb. coal, a not unreasonable figure for a vertical boiler having regard to coal used, the amount of feed would be about 80 lb. per p.h.p. hour, a result that may be compared with that for Pump P working at about the same output.

Pump R.—Compound condensing.

Supplied to deliver 34 g.p.m. against 763′ at 57 f.p.m. Normally worked at about 10 P.H.P. at about 80 f.p.m.

H.P. by formula at 80 lb. steam and 80 f.p.m. is

$$10^2 \times \cdot 075 \times \tfrac{80}{120} \times 2 = 10 \text{ P.H.P.}$$

Deduction.—Fully loaded. A reasonably economical pump when worked at full stroke, but although the steam consumption of 40·75 lb. per p.h.p. hour compares favourably with that for Pump "S" it is greatly in excess of the guarantee of 29 lb. for the flywheel pump "A."

A compound condensing pump is suitable for this case.

Pump S.—Triple-expansion, condensing.

Supplied originally with 6″ plungers, to deliver 8,000 g.p.h. against 157′. This is equivalent to 6·37 P.H.P.

H.P. by formula for 100 lb. steam and 85 f.p.m., the speed at which it is worked, is

$$14^2 \times \cdot 07 \times \tfrac{85}{120} \times 2 = 16 \cdot 2 \text{ P.H.P.}$$

Deduction.—Pump very much too big for the job, even under the altered conditions with enlarged plungers ($7\frac{3}{8}$″ diam.) and a normal loading of about 10 P.H.P.

The pump is very uneconomical in steam.

Compare Pump T with exactly similar steam end, and also Pump U which is worked at 25 P.H.P.

A triple-expansion pump is not justifiable for such a small output under any circumstances.

Pump T.—Triple expansion, condensing.

Steam end similar to Pump "S," but higher boiler pressure.

Supplied to deliver 18,300 galls. in 8 hours against 1,371′ and alternatively to deliver 30,200 galls. in 8 hours against 840′. The heads actually worked against are 1,450 and 850′ normally at piston speeds of 67′ and 85′ respectively. The heavier load is when working against the higher head at the lower speed.

Although not given in the form of a guarantee the steam consumption was stated at 27 lb. per I.H.P. hour.

H.P. by formula for a pressure of 120 lb. and a speed of 67 f.p.m. is

$$14^2 \times \cdot 075 \times \tfrac{67}{120} \times 2 = 16 \cdot 4 \text{ P.H.P.}$$

Deduction.—Suitable.

Digitized by Google

Alternative tenders for this job were Pump B—compound, non-condensing, 27 lb. steam per I.H.P. hour, and Pump C—single cylinder non-condensing, 31 lb. steam per I.H.P. hour. Both fly-wheel pumps. A compound condensing flywheel pumping engine for this job should have done the work on about 26 lb. steam per p.h.p. hour.

Pump U.—Triple-expansion, non-condensing.

Supplied to deliver 200,000 gallons in 8 hours against a head of 187′ at a piston speed of 137 f.p.m. This corresponds to $\frac{2,000,000 \times 187}{8 \times 60 \times 33,000} = 23{\cdot}6$ P.H.P. The pump is normally worked at about that output.

H.P. by formula for 90 lb. steam and 137 f.p.m. is

$$13^2 \times {\cdot}07 \times \tfrac{137}{120} \times 2 = 27 \text{ P.H.P.}$$

Deduction.—Suitable.

The steam consumption recorded in the Table, the results of a test, are very good, especially as there was no super-heat. The pump is jacketed on all cylinders. Jacket steam during test was excessive and amounted to 8·24 lb. per p.h.p. hour, giving a total steam consumption of $8{\cdot}24 + 18{\cdot}35 = 26{\cdot}6$ lb. per p.h.p. hour. Even this result compares favourably with other pumps of this type. The pump was run at a stroke of $15\frac{1}{4}$″ during the test.

This size of pump comes on about the border line between compound and triple.

Pump V.—Triple-expansion, condensing. L.P. jackets.

Supplied to deliver 417 g.p.m. against 133′. This is equivalent to 16·8 P.H.P.

A pump with this stroke can be readily run at a normal piston speed of 125 f.p.m. against a low head, and in emergency could certainly be run up to 150 f.p.m. *Vide* Pump U.

H.P. by formula with 100 lb. steam and a speed of 125 f.p.m. is

$$16^2 \times {\cdot}07 \times \tfrac{125}{120} \times 2 = 37{\cdot}3 \text{ P.H.P.}$$

Deduction.—Far too big for the job. For an output of about 17 P.H.P. a triple-expansion engine is scarcely justifiable.

Pump W.—Compound, non-condensing.

In normal work the pump gives an output of about 25 P.H.P.

H.P. by formula at 80 lb. steam and 90 f.p.m. is

$$16^2 \times {\cdot}06 \times \tfrac{90}{120} \times 2 = 23 \text{ P.H.P.}$$

Deduction.—Pump fully loaded.

A pumping engine of this size should certainly be condensing, where, as in this case, the plant is worked every day in the year for eight hours or more per diem; indeed in this case triple-expansion condensing would have been justifiable.

Digitized by Google

The steam consumption is high (56·4 lb. feed per p.h.p. hour) and compares unfavourably with the flywheel Pump D which works at about the same power.

Pump X.—Triple-expansion, condensing; all cylinders jacketed.

Supplied to deliver 1,000,000 gallons per 24 hours against 360′ at piston speed not exceeding 150 f.p.m. This is equivalent to about 76 P.H.P. Owing, it is believed, to incrustation of the long rising main the head is now about 380′ and the horse-power has risen to over 80 P.H.P. in daily work.

Horse-power by formula with 100 lb. steam and a piston speed of 150 f.p.m. is

$$(21.5)^2 \times \cdot 07 \times \tfrac{150}{20} \times 2 = 81 \text{ P.H.P.}$$

Deduction.—Suitable. As a matter of fact, during the test the results of which are recorded in the Table, although the initial pressure in H.P. cylinder measured off the indicator diagrams was only 75 lb., there was no cut-off and the M.E.P. of the L.P. diagrams was over 12 lb., a rather high figure. These figures nevertheless suggest that this pump is working somewhere near its maximum output when loaded to 80 P.H.P.

Jackets use 3·86 lb. steam per p.h.p. hour giving a total of 23·54 lb. steam per p.h.p. hour; a poor result for an engine of this size.

Efficiency *i.e.* $\frac{\text{P.H.P.}}{\text{I.H.P.}} = 96$ per cent., a very high figure.

General Observations.—The pumps listed in Table IV. have been dealt with in detail partly to illustrate the application of the formula given in Echo No. 20 and partly to invite attention to the performances of the engines concerned.

In the absence of criticism by a fully qualified expert in pumping machinery the formula can only be claimed to give approximate results, nevertheless, as regards pumping engines up to the sizes dealt with above it may be admitted that it will at least serve as *a* guide as to their suitability for the work they have to do.

Most of the pumping engines seem well suited to their work, so far as power is concerned, but it is hard to get away from the deductions applied to Pumps S and V as to their excessive size. It must be remembered that not only does a needlessly large pump entail a high capital cost, but it cannot be expected to work economically when greatly underloaded; this is especially so with a straight-line pump.

Digitized by Google

HISTORICAL DOCUMENTS OF MAJOR-GENERAL SIR J. T. JONES, BART., K.C.B., R.E.

(*Continued*).

In the December *Journal* the reports and instructions for the first and unsuccessful assaults on Badajoz was reproduced. The following papers refer to the final attack in 1812. Most, if not all of the documents, are believed to be in Lord Wellington's handwriting and give some idea of the personal attention he paid to the various details of the operations. The first document is a memorandum from Lord Wellington respecting the despatch of cars to Almeida and Ciudad Rodrigo. The second is also a memorandum respecting the safety of the bridges which had been damaged by the rising of the Guadiana in March, 1812. The third contains instructions for the transportation of shot across the Guadiana. The fourth contains instructions for blowing up the dam of the Lunette at Badajoz on the 2nd April, 1812. Nos. 5 and 6 are two rough memoranda from Lord Wellington concerning the bridge of boats at Villa Velha and the site of the flying bridge. The seventh manuscript is of particular interest. It is, apparently, in Lord Wellington's handwriting and is docketed by Sir J. Jones as "Original Orders for Assault on Badajoz, 1812." It gives minutely the details for the Assault on Badajoz and has a supplementary order giving "Notes" on the various paragraphs. Finally No. 8 is a letter from Lord Wellington to Sir Richard Fletcher, dated May 25th, 1812, giving detailed instructions for the repair of Badajoz.

No. (1). *Memorandum from Lord Wellington respecting the Transport of Stores to Ciudad Rodrigo.*

Separate Memorandum.

For Mr. Bissett.
Col. Fletcher.
Major Dickson.

FRENEDA, *January 1st*, 1812.

Ninety cars now at Freneda and sixty-six expected from Brigadier Alava to be sent on the 2nd to Almeida, to be loaded, 106 with Engineer's Stores and 50 with small stores of the Artillery; to carry these articles on the 3rd to Gallegos; return on the 4th to Almeida, and load with Powder and Shot; return on the 5th to Gallegos and lay down the Powder and Shot, and to be reloaded with Engineer's stores to proceed to Ciudad Rodrigo on the 6th.

W——.

Digitized by Google

No. (2). *Memorandum by Lord Wellington concerning the Safety of the Bridges on the Guadiana, March, 1812.*

Memorandum, March 22nd, 1812.

1. The Pontoon bridge to be taken up, and brought to this side of the River. A report to be made as soon as possible of the damage received; and inform Lt. Piper that it is very extraordinary that he should not have reported the damage to this hour; or even that any accident had happened.

2. The stage on the Right of the River for the flying bridge to be replaced as soon as possible: that part of the stage on the left of the River which is not necessary to be taken up.

3. At all events the Planks on both stages to be taken up during the night.

4. Mr. Piper Report whether it will be necessary to place Pontoons on each side of the River to communicate with the flying bridge.

(3). *Instructions from Lord Wellington for conveying Shot across the Guadiana.*

Memorandum, March 26th, 1812, for the Chief Engineer and Officer of Artillery and Q.M.G.

Mr. Piper to be desired to employ six Pontoons as Row boats near the flying Bridge to carry over principally Powder and Shot.

Care must be taken that they are not overloaded; not more than 40, 24 Pr. Shot to be put in each or an equal quantity of Powder.

Planks must be placed in the bottom, and the lower part of the sides should have a plank in order to prevent the Shot from rolling against the sides.

The Pontoons must not be used as Passage boats.

Mr. Piper to be requested to mention in his Reports whether he has Bullocks in sufficient numbers and in good order to move the Bridge.

(4). *Memorandum by Lord Wellington for blowing up the Dam of the Lunette, April 2nd, 1812.*

Memorandum, April 2nd, 1812.

An attempt is to be made this evening at ½ past 7 o'clock to destroy the dams in the Rivillas.

A Gun in No. 7 must be turned at 3 P.M. to fire occasionally upon the Howitzer in the Rear of the left flank of the Ravellin of St. Roque; which fire must be continued till the party will move to make the attempt.

Digitized by Google

50 Men of the covering party in the trenches must enter the covered way of the Ravellin at the place where the Palisades are destroyed at the Salient Angle, and proceed along the left face of the Covered Way, by turning to the Right after entering.

The men must be attended by 12 Carpenters to enable them to cut down the Gate or Palisade which is between them and the River Rivillas.

(5). *Instructions by Lord Wellington regarding the Bridge of Boats at Villa Velha.*

Memorandum, April 10th.

Major Burgoyne is to set out this evening for Villa Velha and if possible to arrive there to-morrow.

If on his arrival at Villa Velha he should find the Enemy at Castello Branco, he is to have the Bridge taken up at Villa Velha, and all the materials put into the Boats; and the Boats must be sent about a League down the Stream and kept there on the left bank in a place to which the Enemy cannot get at them, ready to be drawn up and replaced as a Bridge, as soon as the Corps will arrive at Villa Velha to cross the Tagus.

The bridge is not to be taken up till the Enemy arrive at Castello Branco.

The 1st Hussars have been ordered to Castello Branco and Major Burgoyne should communicate with Genl. Alten and General Le Cor.

(6). *Pencil Instructions by Lord Wellington on April 21st.*

Memorandum.

1. Fix the place for the flying Bridge.

2. Order one bridge at ——— to be placed on its carriage.

3. Order the Superintendents of Transports here to provide 300 Carts to attend the army at the Siege of Badajoz.

(7). *Original Orders by Lord Wellington for the Assault on Badajoz on 6th April, 1812.*

There may be some alteration in this plan which will be communicated by reference to the Number of the Paragraph altered.

No. 1. The fort of Badajoz is to be attacked at 10 o'clock this night.

No. 2. The attack must be made on three points; the Castle, the face of the Bastion of La Trinidad; and the flanks of the Bastion of Sta. Maria.

No. 3. The attack of the Castle to be by escalade; that of the two Bastions by the Storm of the Breaches.

Digitized by Google

No. 4. The Troops for the Storm of the Castle consisting of the 3rd Division of Infantry should move out from the right of the 1st Parallel at a little before 10 o'clock, but not attack till 10.

No. 5. They should cross the River Rivillas below the broken bridge over that River; and attack that part of the Castle, which is on the right looking from the Trenches, and in the Rear of the great battery constructed by the Enemy to fire on the bastion of La Trinidad.

No. 6. Having arrived within the Castle, and having secured the possession of it, parties must be sent to the left along the Rampart, to fall on the Rear of those defending the great breach in the Bastion of La Trinidad; and to communicate with the Right of the Attack on that Bastion.

No. 7. The Troops for this attack must have all the long ladders in the Engineers' Park; and Six of the Lengths of the Engineers' Ladders. They must be attended by 12 Carpenters with Axes; and by Six Miners with Crowbars, etc.

No. 8. The 4th Division with the exception of the Covering party in the Trenches, must make the Attack on the face of the Bastion of La Trinidad; and the Light Division the attack on the flank of the Bastion of Sta. Maria.

No. 9. These two Divisions must parade in close Columns of Divisions at 9 o'clock. The Light Division with the left in front, the 4th Division with its Advanced Guard with the left in front; the remainder with the Right in front. The 4th Division must be on the Right of the little Stream near the Picquet of the 4th Division; and the Light Division must have the River on their Right.

No. 10. The Light Division must throw 100 Men forward into the Quarries close to the Covered Way of the Bastion of Sta. Maria, who, as soon as the Garrisons are disturbed, must keep down by their fire, the fire from the face of the Bastion of Santa Maria; and that from the Covered Way.

No. 11. The Advance of both Divisions must consist of 500 men from Each, attended by Ladders; and the men of the storming party should carry sacks filled with Light Materials, to be thrown into the ditch to enable the troops to descend into it.

Note.—Care must be taken that these Bags are *not* thrown into the Covered Way.

Digitized by Google

No. 12. The Advance of the Light Division must precede that of the 4th Division; and both must keep as near the innundation as they possibly can.

No. 13. The Advance of both Divisions must be formed into firing parties and storming parties. The firing parties must be spread along the Crest of the Glacis to keep down the fire of the Enemy; while the Men of the Storming party who carry bags, will enter the Covered Way at the Place d'Armes under the breached face of the Bastion of La Trinidad; those attached to the 4th Division on its' right, those to the Light Division on its left, looking from the Trenches or the Camp.

Genl. Colville will observe that a part of the advance of the 4th Division must be allotted to Storm the new Breach in the Curtain.

No. 14. The Storming party of the Advance of the Light Division will then descend into the Ditch and turning to its left, storm the breach in the flank of the Bastion of Sta. Maria; while the Storming party of the 4th Divn. will likewise descend into the Ditch, and Storm the Breach in the face of the Bastion of La Trinidad. The firing parties are to follow immediately in the Rear of their respective storming parties.

No. 15. The Heads of the two Divisions will follow their Advanced Guards, keeping nearly
2 together; but they will not advance beyond the Shelter afforded by the Quarries on the left of the Road, till they will have seen the Heads of the Advanced Guards ascend the Breaches. They will then move forward to the Storm in double quick time.

No. 16. If the Light Division should find the bastion of Sta. Maria intrenched they will turn to the Right of the Intrenchment moving along the parapet of the Bastion. The 4th Division will do the same by an intrenchment, which appears in the left face, looking from the Trenches, of the Bastion of La Trinidad.

No. 17. The Light Division as soon as they are in possession of the Rampart of Sta. Maria, are to turn to their left, and to proceed along the Rampart to their left, keeping always a Reserve at the breach.

No. 18. The Advanced Guard of the 4th Division are to turn to their left, and to keep up the Communication with the Light Division. The 4th Division are to turn to their Right, and to communicate with the 3rd Division, by the Bastion of San

Digitized by Google

Pedro, and the Demi Bastion of San Antonio, taking care to keep a reserve at the Bastion of La Trinidad.

No. 19. Each (the 4th and Light) Division must have 1,000 Men in reserve in the Quarries.

No. 20. The 4th Division must endeavour to get open the Gate of La Trinidad; the Light Division must do the same by the Gate called Porto de Pillar.

No. 21. The Soldiers must leave their Knapsacks in Camp.

No. 22. In order to aid these operations the Howitzers in No. 4 are to open a fire upon the Batteries constructed by the Enemy to fire upon the breach, which they must Continue till they see that the 3rd Division are in possession of the Castle.

Will observe that the Enemy are aware of the attack.

No. 23. The Commanding Officer in the Trenches is to attack the Ravelin of St. Roque with 200 Men of the Covering party, moving from the Right of the Trenches; and round the Right of the Ravelin looking from the Trenches; and attacking the Barriers and Gates of Communication between the Ravelin and the Bridge; while 200 Men likewise of the Covering Party will rush from the Right of the Sap into the Salient Angle of the Covered Way, of the Ravelin; and keep up a fire on its' faces.

The Attack Order in this Paragraph should be made from the right of the Sap instead of from the right of the Trenches.

The Commg. Officer in the Trenches must begin it as soon as he will observe that the attack of the 3rd Division on the Castle is perceived by the Enemy.

These last should not advance from the Sap, till the party to attack the Gorge of the Ravelin will have turned it. That which will move into the Covered Way on the right of the Ravelin looking from the Trenches, ought not to proceed further down than the Angle formed by the face and the flank.

No. 24. The remainder of the Covering Party to be a Reserve in the Trenches. The Working Parties in the Trenches are to join their Regts. at ½ past 7 o'clock.

Twelve Carpenters with Axes and Miners with Crow Bars must be with each (the 4th and Light) Division. A Party of one Officer and 20 Artillery Men must be with Each Division.

No. 25. The 5th Division must be formed, one Brigade on the ground occupied by the 48th Regt., one Brigade on the Sierra de Vento, and one Brigade in the low grounds extending to the

Digitized by Google

Guadiana, now occupied by the Picquets of the Light Division.

A Plan has been settled with Lt. Genl. Leith for an attempt to be made to escalade the Bastion of St. Vincente or the Curtain between the Bastion and the Bridge if Circumstances should permit.

No. 26. The Picquets of the Brigades on the Sierra de Vento, and that in the low grounds towards the Guadiana should endeavour to alarm the Enemy during the attack by firing at the Pardaleras, and at the Men in the Covered Way of the Works towards the Guadiana.

The Commg. Officer of the Light Division will attend to this.

Genl. Power will likewise make a false attack on the Tête de Pont.

No. 27. The Commt. of the Forces particularly requests the General Officers Commg. Divisions and Brigades, and the Commg. Officers of Regts. and the Officers Commg. Companies to impress upon their Men the necessity of their Keeping together, and formed as a Military Body after the Storm, and during the night. Not only the success of the operation and the honour of the Army, but their own individual safety, depend upon their being in a situation to repel any Attack by the Enemy, and to overcome all resistance, which they may be inclined to make, till the Garrison will have been Completely Subdued.

Supplement to Original Order for Storming Badajoz, 1812.

Note upon the 6th Paragraph.

It is recommended that the attack of the 3rd Division should be kept clear of the Bastion of San Antonio, at least till the Castle which is above, and Commands that Bastion will be carried.

Note upon the 9th Paragraph.

This arrangement of the columns is made, in order that the Light Division may Extend along the Ramparts to the left; and that the 4th Division with the exception of the Advanced Guard, which is to communicate by its left with the Light Division might extend along the Ramparts to the Right. It may be necessary however for these Divisions mutually to support each other, and attention must in this case be paid to the formations.

No. 13 will run thus after the words "While the Men of the Storming party who carry Bags will enter the Covered Way" insert those of the Light Division at the Place d'Armes on the left, looking from Camp, of the unfinished Ravelin; those of the 4th Division on the right of that Ravelin at the Place d'Armes under the breached face of the Bastion of La Trinidad.

Digitized by Google

*No. 14. General Colville will observe that a part of the advance of the 4th Division must be allotted to storm the new breach in the curtain.

Note on No. 15. The Place here pointed out may be too distant. The Heads of the Columns should be brought as near as they can without being exposed to fire.

Note on No. 19. It will be necessary for the Commg. Officer of the Light Division to attend to the Ditch on his left as he will make his attack. He should post a Detacht. in the Ditch towards the Salient Angle of the Bastion of Santa Maria ; so as to be covered by the Angle from the fire of the next Bastion on its left looking from the Trenches.

Note on No. 22. Some signal must be arranged between the Commg. Officer of the Artillery and the Officer who will command the attack, on the Castle, for ceasing the fire in No. 12.

Note upon No. 23. It would be better that this Attack should move from the Right of the Sap.

†The Commg. Officer in the Trenches must begin it as soon as he will observe that the attack of the 3rd Division on the Castle is perceived by the Enemy.

2 ‡Memn.—A plan has been arranged with Lt. Genl. Leith for an attempt to be made to escalade the Bastion of St. Vicente or the Curtain between the bastion and the Bridge if circumstances should permit.

No. 26. 1 The Commg. Officer of the Light Division will attend to this.

General Power will likewise make a false attack on the Tête de Pont.

(8). *Letter from Lord Wellington to Sir Richard Fletcher approving of the Proposed Repairs to the Defences of Badajoz.*

MONTE GRIMALDO, *May 20th*, 1812.

MY DEAR SIR,

I have received your letters of the 17th and think that everything in the shape of boat should be sent to Elvas ; and you should apply to the Govr. of that Fortress for carriages from the boats already sent for the two Launches which you mention.

* Added in pencil.

† *Ibid.*

‡ These 3 last paras. were added in the margin of the original orders.—See ante.

Digitized by Google

As the weather will soon become very hot in Estemadur, you should take care not to work your Englishmen in the heat of the day.

It does not appear to me to have been necessary for Lt.-Col. Jones to resign his office of B. Major to the Engineers when appointed a Lt.-Col. by Brevet. But I have no objection to your appointing Captain Eilicomb to the situation till the pleasure of the Master-General will be known; nor to Col. Jones' going on the proposed Service.

By letters from Lord Mulgrave I learn that about 90 Sappers and Miners are coming here immediately. You had better give orders that if they should arrive they should go with Col. Jones. I'll endeavour to have Horses sent for the Officers, but I believe the best way would be to have places made for them in the ships with the Men; and that the Comt. should supply Hay and Corn for them. Lt.-Col. Jones might arrange this with the Agent of Transports.

I have considered the plan and estimate of the expense of the Improvements which you propose to the Works of Badajoz; and I have numbered them as they stand in your Estimate; and in giving my opinion I shall refer to the Number.

I concur with your reasoning upon the difficulty of connecting the *Picurina* with the Inundation; and approve of what you propose for the Communication and of the Expense of No. 1.

It appears to me that the expense of the wall in No. 2 to cover the existing sluice in the gorge of the Ravellin of St. Roque will not be necessary; if you should —— the Dam with the Sluice lower down the Revillas. You will observe however that this Dam and Sluice will be liable to the same danger as that is which now exists; viz. that of being destroyed by a mine by surprize; and it may be expedient to have a Wall in its front, as I proposed for the existing Dam or Sluice. You must be the best Judge of the necessity for the expence in No. 2, if you incur that in No. 4; of which I approve. I approve of the Sluice Gates to the Covered Drain which communicates from the Inundation to the Ditch.

I approve also of the excavation of the Ditch from the Inundation to the Quarry.

In regard to the works estimated for in No. 6 and No. 7, I consider them to be absolutely necessary. When all will be completed which we propose towards the Revillas, the point of attack which will be most eligible is the Right of the Pardaleras. Indeed that point has always in my opinion been the weakest, particularly in reference to an attack by the French who are well supplied with Sappers and Miners. But the Expense and the time which these works will require become matters of serious consideration.

I wish you could speak to the Marquis de M—— respecting the works estimated for in No. 6, 7, and 10. Point out to him how important it is that these works should be compleated; and let

Digitized by Google

him see the estimate of the Expense, and ask him whether the Province or Town or the Spanish Govr. will defray it. Let me know the Result; and I will then determine what I will do.

I approve of the work to the glacis of St. Christoval; and of that estimated in No. 9 to cover the left face of La Trinidad and the Right face of St. Pedro.

I have not made myself sufficiently understood respecting the admission of the Waters of the Guadiana with the Ditch. I see that the inundation of the Revillas can go but little further than it is; the point L in the plan. Can the Waters of the Guadiana be brought into the Ditch at all; and if they can how far at a reasonable rate of Expence. I should wish to have an answer to this Question referable to the State of the Guadiana at present, and to the State in which it is in the floods which usually occur every year.

You will observe that by Inundation and other measures the points of attack at Badajoz have been very much narrowed. They could be still more narrowed if by throwing the water of the Guadiana into the Ditch we could have a Wet Ditch as far as the Bastion No. 2, or even No. 1.

Ever your's most faithfully

WELLINGTON.

LT.-COL. SIR RD. FLETCHER.

You might Drive Piles or adopt any other mode for a Bridge across the Ditch to communicate with the Ravellin St. Roque. It will not answer to leave boats at Badajoz.

Digitized by Google

A LADY'S EXPERIENCES IN THE GREAT SIEGE OF GIBRALTAR (1779–83).

BEING THE DIARY FROM 1ST JUNE, 1779, TO 13TH JUNE, 1781, OF MRS. GREEN, THE WIFE OF LIEUT.-COLONEL GREEN, CHIEF ENGINEER OF GIBRALTAR (AFTERWARDS LIEUT.-GENERAL SIR WILLIAM GREEN, BART., CHIEF ENGINEER OF GREAT BRITAIN, 1786—1802).

THE MS. of this diary, which has never before been printed, is the property of Major-General O. H. Nicolls, late R.A., the great-grandson of Sir William and Mrs. Green, who has very kindly allowed it now to be published. Except for the occasional correction of an obvious mistake in spelling and for the somewhat free revision of punctuation (of which, however, the general characteristics are preserved as far as possible) the MS. is reproduced *verbatim et literatim*, a very few private lines only being omitted and also a detailed private account of the illness and death of a maidservant from small-pox. There being two versions of the greater part of the diary,—both written by Mrs. Green—much of this reproduction is a compilation from the two. The original language has been everywhere preserved but the two versions have been blended together where necessary in order not to omit any fact or comment included in either of them. The diary is not only of interest as giving a lady's experiences of the Siege which has hitherto been only described from the soldier's point of view, but also throws additional light on the trials borne by the garrison and the military events of the Siege. For instance, although Drinkwater and Spilsbury both mention the slight outbreak of small-pox in October, 1779, they make no allusion to the much more serious outbreak which looms so largely in Mrs. Green's diary from 15th January, 1780, to 15th July and which carried off some 500 people, chiefly children, including about 50 soldiers.

Sir William Green whose mother was a daughter of Adam Smith, author of *The Wealth of Nations*, obtained his first appointment in the Corps of Engineers on 12th March, 1744, as Practitioner Engineer. On 14th May, 1757, military rank was granted to the Corps and he was then commissioned as captain-lieutenant. He served at Fontenoy in 1745 and under Wolfe at the capture of Quebec in 1759, when he was wounded, and in 1760 was sent as a major to Gibraltar to command the Engineers and to fortify the place, or rather to bring its fortifications up to date. In 1762 he was promoted to lieutenant-colonel; and in 1772 the

Digitized by Google

Company of Military Artificers which afterwards developed into the rank and file of the Royal Engineers, was formed on his recommendation. During the great siege of 1779—1783 he was promoted to the rank of major-general. He was created a Baronet in 1783 as a reward for his services during the Siege; and from 1786 to 1802 he was Chief Engineer of Great Britain. He retired in 1802 and died in 1811. During the Siege his official quarter was approximately on the site of that which is still the Chief Engineer's Quarter, but he also had a private residence "Mount Pleasant" which he had built for himself outside the town and Mrs. Green's diary shows that both houses were used by them during the first two years of the Siege, and that at both of them bombproofs were constructed for use by the family whenever the enemy should bombard. At the "Mount,"—now the official residence of the Senior Naval Officer,—one of these shelters still remains and is used as a reservoir. It is possible that some of the underground tanks at Engineer House may have been formed out of Green's bombproofs, but the house was "entirely destroyed at the commencement of the enemy's fire from their batteries upon the Isthmus,"* *i.e.* in the bombardment of April, 1781. "The Mount" was sold by Green to the Admiralty in 1797, and the present residence on that site was built between that year and 1811, being considerably altered in 1846 and again enlarged in 1905. The baronetcy expired with Sir William Green's son, Lieut.-Colonel Sir Justly Green, who commanded the 1st Royals and was afterwards Military Preceptor to H.R.H. the Duke of Kent, father of Queen Victoria.

Mrs. Green was the eldest daughter of Colonel Justly Watson of the Corps of Engineers and grand-daughter of Lieut.-Colonel Jonas Watson, R.A., Chief Bombardier of England, who was killed at the Siege of Carthagena in 1741, aged 78. She died on 21st June, 1782, in England,† from the effects of a chill caught in the bomb-proofs in which she had to shelter in Gibraltar.‡

A few Mem^a relating to what passed in the Garrison of Gibraltar; during the Investment, and Blockade which commenced upon the 21st of June 1779—and a few Mem^a of what had passed, about 3 weeks before it happened, by which it may be seen how Unexpected such an Investment was to the English in Gibraltar. To make this more clear I shall begin with the first of June.

1779.

June Tues^d 1st. I was Then very ill, Confined to my room, and found it would be impossible for me to go to the Ensuing Birth

* W.D. Bill Book No. 228 at the Record Office.
† Porter's *History of the R.E.*, Vol. I., p. 107.
‡ *Dictionary of National Bibliography.* Article on Sir W. Green.

Digitized by Google

Night; for which there was great preparations making, and I learn 1st June, 1779.
that our Gov^r had been out himself to Invite the Spainish Gov^r of St Roque, Don Joa^in Mendoza and his Lady and all the Spainish officers to come In upon the 4th of June, which shew'd all was Well at that time; My Complaints Still remain bad,—all the 2nd, 3rd, and indeed for the rest of the month.

4th. Great bustle in the Garrison. The Field officers and Staff, all at Dinner at the Convent. At Noon there was as Many Guns as the King was years old. In the afternoon the Spainish Gov^rs Lady and Several officers came in; but not the Gov^r himself, At Sunset there was a feu-de-joye. Madame Mendoza went from the Line wall, where she had seen the Firing, to the Convent; where there was a very Grand Gala, a Ball; and the Inside Court Yard, all round the Colonade, was finely Illuminated, and all possible pains taken on the occasion.

From the 4th to the 15th I continued greatly indisposed, and in my Room most of the time; all this time things were very quiet, and Several of the officers and their Familys had gone out to St Roque, and in that Neighbourhood to stay for the rest of the Summer.

On Saturday the 19th the Gov^r and all the Colonels and Field officers of this Garrison were desired by the Gov^r to attend him in a Visit He made to Don Joaquin Mendoza, the Gov^r of St Roque, upon hearing of his having been promoted to the Rank of Lieut Genl. They formed a large Cavalcade, It was a very Warm Day. N.B. They returned to dinner. It was remarked that He did not receive This Visit as He ought to have done; but Seemed Uneasy the whole time they staid—which was not very long—as He did not even ask them to Partake of any Refreshment; and which indeed They ought to have had ready for our Gov^r &c, as they knew of his intended Visit. By what so soon happend, We can not help thinking that He had Rec^d some private hints, and in all likelihood was distress't at this Visit, Madame was there. The Party all came back in good Spirits, tho not much pleased. They all dined at the Convent.

Sun^d 20. I am much better and went to Church. Many people Riding out into Spain, and all quiet.

Mond^y 21. The Mail went out to St Roque as Usual, but We had not any come In! which We did not mind at first, as it is not Uncommon for the Mail to stay an hour later than common. However we soon learnt the occasion. In the afternoon as some of our English officers were Riding out they were inform'd by the Spainish officers at the Lines that they must not go through, Not only that but that all the officers and families who were out were orderd into the Garrison directly, and also every English Person, not even allowing them to bring away those Necessarys they had taken out with them. Mr Davies and Family were there, also Mr Booth and Family, Capt and Mrs Montgomery, of the 12th, and Several others,

Digitized by Google

21st June, 1779. With great difficulty the Spainish Govr allowed them to stay that one Night, but by 3 oclock He hurried Them away. From that hour all communication was shut up. At this time Colonel Ross and Captain Vinogles of the 39th was in Spain upon a Tour, and at Malaga when they heard of this. They Set off directly and arrived at St Roque on *Wednesday the 23rd*, but was not suffer'd to come into this Garrison! the Govr Assuring them it was not posible for him to let any Body come into Gibr. They were thus obliged to go to Cadiz. There they staid some time, till an answere was returned from Madrid. They were then allowed to go anywhere but to this Garrison. They went to Farro,* From thence they got a Boat, and arrived at Gibr upon the *25 July*, as well as did Capt Lafanue of the 56th who had got as far as Lisbon by means of a Convoy, Under Capt Allen, of the *Chatham* Man of War, who sailed out upon the very Morning of the 25th before it was known of our Communication being Stopt. It is not impossible but Mendoza waited on purpose to let them be saild first, before He sent In Word, as He has a full View of all that passes in this Bay. Capt Lafanue left all the Convoy at Lisbon, but that the Levant Frigate, Captain Murry, was gone home express. I think his going was owing to the first Paquet Boat, which went from this, which was upon Tuesday 29th June to Farro, by which I wrote to My Sister and to Capt Nicolls,†—and thus ended this month. Only I am to remark that a vast Number of Ships and Xebeques‡ were daily going over to Algezira, and from them Several Smaller Vessels went to the Orange Grove.

July began very quiet. I was tolerably well and in pretty easy Spirits, tho' at times We had our Fears particularly as our Admiral did not seem overforward to let any of our Ships go out to stop any Thing that was daily going over the Way. Several Persons in the Garrison Seem'd Inclined to Man Vessels by way of Privatters. In the beginning of this Month 3 Fine Cutters came In from Engl[d] fitted out as Privateers to take either French or Americans. They were stout Vessels indeed.

Sund 11th. I went out to the Mount. Several Large Ships appeared round Europa, and at Noon made Signals to the Admiral, who sent out the *Childers* Sloop of War. She found it was a large Number of Xebeques and other arm'd Vessels. A pretty Smart Engagement began, between the *Childers* and the 3 Cutters. It was from them as they were out cruizing that the Signals were made. They took Several Small Prizes of wine &c. It was now Eagerly

* A small port on the south coast of Portugal, frequently mentioned in this Journal, being the nearest neutral European port.

† Husband of Mrs. Green's eldest daughter, afterwards General Oliver Nicholls. He was in the 1st Royals.

‡ A small sailing vessel.

Digitized by Google

wishd and expected that the Admiral and the only Frigate viz. the *Enterprize*, Sir Thomas Rich, would hasten out, as it was pretty certain this was a fleet intended for Algezira. At last Admiral Duff did make a Signal. The *Enterprize* got ready as Soon as possible, but it was 5 oclock before the Admiral got out. It was by much too late! and the Fleet got through that Night. This occasioned great discontent and in consequence some Vowes &c were made. 11th July, 1779.

Fri[d] 16. Two Line of Battle Ships, of 74 Guns each, went over to Algezira, from which time it may be reckon'd a fair Blockade, as it can hardly be expected that any Vessel will be allowd to come into the Bay.—We hear that the Fleet over the Way is to be under the Command of Don Antonio Barcelo, and it is well known that He is a Brave officer.

Sun[d] 18. At Mount Pleasant. The whole Garrison seems displeased and Uneasy. Not any Vessels of late has come from Barbary, and our live stock is but little.

Mon[y] 19. The Colonel does not Seem to like our Situation at this time, and has order'd many things in the publick Way, and also inform'd me that He thinks it will be Necessary to be attentive to our having a good Quaintity of Useful Family things laid In. This *Even*[g] I was taken with a Cold Shivering like an Ague; and think I shall go to Town. Mr Logie, the English Consul, went over to Barbary.

Tues[dy] 20. The Colonel came out pretty Early, and inform'd me that the Garrison was this Morning put under an allowance of Fresh Meat! Each Corps is to draw in Proportion to their Number and the officers to have their Proportion, in Consequence our share came to two pounds, six ounces. N.B. This was what was allowed us to buy at the Common Market. He seemed so Very Uneasy, and said He was so much hurried, and at the same time not Well, that I was resolved not to Remain out any longer, as I thought I might be of Some little Use in Town at such a time as this. It was this Day reported that Mr Logie was taken in going over—(but it was not true, as We heard afterwards). The Vessel was Certainly Boarded by the Spainiards, and he was in the Dress of a Moor, not only So but hid himself under some Sails, and by that Means escaped. Otherwise He would most likely have been taken either to Ceuta or to Algezira.

Wed[y] 21. I came into Town and find things a little better. A Boat had arrived from Tangier with 48 Bullocks. The Col. now seemed greatly indisposed, and upon Sunday 25 was so much that Doctor Baynes* advised him to be attentive to himself. This afternoon it was observed that the Spainiards had pitched one Tent near to Fort Negro.

* Surgeon-Major Arthur Baines.

Digitized by Google

26th July, 1779. *Mon*^{d} 26. The Col had been much indisposed, and restless all Night. I really believe his Anxiety made him Worse. This Morning We saw a good Number of Tents pitched upon the Plains, or the Common, of St Roque, forming Several Streets. It now becomes Necessary to attend to every point, as it is not to be doubted but the Intention of the Spainiards is to attack this Garrison. I shall therefore from this time call them—*The Enemy*—whenever I have occasion to speak of them, which I shall do as long as Circumstances enable me to continue this Unconnected, Rough, Journal—and much I fear I should fall Short of any Stile or Method, were it intended for any Persons Information except such of my Family Friends who perhaps will not Dislike to pass an Idle hour in looking over these pages. God only knows who may have the Sight of this Book or who may ever See the Person who now writes this; however I go on; *Miriam Green.*

Tues 27. This day a Pacquet Boat went to Farro by which I wrote to my Sister. The Col still indisposed. Many Persons calling; and the Gov^{r} expressing great Uneasiness at the Col's indisposition.

Wed 28. This day the Enemy encreasing their Encampment and making great Preparation. In the Forenoon the Gov^{r} came to our House and had a very long Conversation, and fixed many points with the Colonel. He also appointed the Staff of the Garrison, and fix'd upon his aid-de-camps, also many other matters, advising the Colonel not to attempt Stirring out till he was quite Well, as his Health now became a publick Concern. All this time and to the End of this month the Enemy continued very Busy indeed. Several of the Inhabitants families gat away by order and some indeed from Inclination. Inhabitants were order'd to Lay In for six months at Least. I now began to Fear upon the whole.

The Staff of the Garrison was settled as follows

Aid de Camps to the Governor, Captain Vallotton, 56th Regt. Captain Paterson, Royal Artillery, Captain Evelegh, Engineers, Captain Forch, 12th Regt.

Aid de Camps to Lt Governor,* Captain Wilson, 39th Regt, Lt Buckeridge, 39th Regt.

Aid de Camp to Lt Gen^{l} La Motte,† Captain Wenzee, Lt Gen La Motte's.

The Brigade Major to Hanoverians, Captain Lowder, Hardenbergh's.

Adjutant Gen^{l} Major Horsburgh, 39th; Quarter Master Gen^{l} Major Hardy, 56th.

Town Major, Captn Burke, 58th.

Assistant Engineers, Lt Burton, Royal Artillery; Lt Chambre, 56th Lt Att, 72nd; Lt Schants, Hardenbergh's.

* Lieut.-General Robert Boyd.

† Commander of the Hanoverian Brigade which consisted of L Motte's, Hardenburg's, and Reden's regiments.

Digitized by Google

Mr Evans, Draughtsman to Chief Engineer; Mr Tingling, Draughtsman to Chief Engineer. 28th July, 1779.

Director of the Hospitals, Doctor Baynes; and Several additional Overseers in the King's Works.

The Colonel also appointed Lt Holloway* of the Engineers to attend upon him in some particular Dutys, which obliges him to have one officer constantly about him; and He became one of our Family.

The Colonel got better now every Day. From this time the Garrison was in constant Bustle, and in getting every thing in the best order. The Enemy also making very great Preparations, Unloading Stores, Pitching more Tents, &c, &c, and Thus ended the month of July. Various were the opinions; tho' it Seemed most probable that the Enemy's Intentions were to make every possible and effectual Trial to Establish a stronger Blockade, nor were they Idle to keep that Spirit up, as No one Vessel appear'd, either from the East or West, that Barcelo did not try to Stop, and most times with Success, He must be allowed every praise due to a good officer, altho' an Enemy.

August 1. The beginning afforded no very Essential Matter. Not any Vessels came over from Barbary. We now Endeavoured to Lay In as good a Stock as possible, and all sorts of family Articles were Sought for and Laid In. It is to be remark'd how very greatly the Inhabitants that kept little shops used to impose upon any Body. Nor were the Merchants backward in that respect! and most things were now fifty pr cent dearer than before.

*Sun*d *8th.* Miss Wards left Gibraltar in a Swedish ship, also Miss Hardy. I wrote to my Son and to Helen. This Day Lt Skinner of the Engineers declared his Marriage. All pretty quiet.

*Tues*d 10. I wrote to my Sister by a pacquet Boat by Farro.

27th. I wrote to my Son by a pacquet Boat, but it did not Sail till the first of Septr. Nothing happend particular the rest of this Month. It now became quite fashionable to get all the News each one could Collect; and by Way of Gaining all that, every Body was Using Spy Glasses from Morning to Night. All those that *affected* great *Cleverness* were ever ready with a pencil and paper, and it was realy Laughable enough to see with what a Jealous Eye each Aid de Camp look'd at the other, fearing *He* should be the first to communicate his *Ideas* of what He supposed the Enemy was about! Various therefore was the Reports, and could not always agree. Those remarks I have made (Such as I could not possibly make from my own Personal Observation) I think may be depended upon as they are from our own Corps, and mostly from the Gentleman that is in the Colonel's family, who would hardly bring a false account.

* Afterwards Major-General Sir Charles Holloway.

Digitized by Google

1st September, 1779. *Septembor 1st. Wedy.* Easterly wind, exceedingly Warm and Close. Hear that the pacquet Boat had sailed for Farro in the course of last Night, and that those Vessels which were in Sight last Night were gone through. N.B. At this time the camp had not made any Material alteration for some Days, excepting two more Laboratory Tents, making 5 in all.

Thurd 2d. Westerly wind. At one this Morning it rained exceedingly hard for half an hour, the first rain this Season. We all expected it would be Worse as at this time of the year it is often very Violent, but it turn'd out a pleasant Morning and forenoon. We this Day Laid In Several family Matters. No change in Camp this Day. Beef very bad at Market, and only 3 Bullocks to be killd, and those very Dear.

Fry 3rd. Westerly wind. Fine Morning. The Spainiards busy in Unloading Stores at the Orange Grove ; and every Morning and Evening they bring down from that Landing place and from Fort Negro, Large Quaintitys of Stores in Carts, likewise many Cannon may be Seen from our Upper Batterys. Great complaints are now making in the Garrison for Want of fresh Provisions, not any Beef or Mutton in the Market to Day. Inhabitants, particularly Jews, are Laying In provisions for Six Months.

Saty 4. Westerly wind, pleasant Morning. A pacquet Boat arrived from Farro, last from Tangier, brought 10 Sheep only ! An other Regt came to the Camp this morning. Some few persons had letters from England, but none from our Friends. No meat in Market Mid-Day had Soup Meagre for the first time.

Sund 5th. Westerly wind. Exceedingly Close and Damp. No Boats would Venture over to Barbary upon account of the Spainish cruisers. A man of the Hanoverians deserted this morning, was fired at from Williss. The wind came Easterly in Evening.

Mond 6th. Easterly wind. The Same Close Damp Weather. This Evening a Boat went to Tangier in which Several Inhabitants went over. Amongst the Number were Mr Butler, Dutch Consul, and his Niece. I wrote by this opportunity to My Daughter Nicolls. The Same Movements in the Camp. Most people now begin to think *We* ought to take Some Notice of our Neighbours, as they continue to *Work* on very Briskly ; and are very Busy at Fort Negro, Fort St Philip and Fort Barbara.* Our *Admiral* and his Small Squadron remain perfectly quiet. Many Town Vessels go out and are very active !

(*To be continued*).

* St. Philip was on the west, and Barbara on the east, flank of the Spanish lines, the ruins of which still remain on the Spanish frontier.

Digitized by Google

Digitized by Google

Lieut.-Colonel Henry F. C. Lewin, Royal Engineers.

(Date about 1880).

Digitized by Google

MEMOIR.

LIEUT.-COLONEL HENRY F. C. LEWIN, ROYAL ENGINEERS.

By COLONEL R. H. VETCH, C.B., LATE R.E.

IT is always sad when someone we have known as a boy passes away from this world and we reflect that in spite of occasional meetings in after life no opportunity has offered or, if offered was seized, of closer acquaintance and friendship. We feel that something has been missed in life. This thought struck me when I was asked to write a short notice for the *Royal Engineers Journal* of my old schoolfellow, Lieut.-Colonel H. F. C. Lewin.

A brother officer, an old friend of Lewin, who was first asked to write it, objected that his friend, like himself and nine-tenths of the R.E. officers, was, as far as he was aware, never employed outside ordinary routine work of the Corps, about which he thought nothing could be written. Nevertheless he suggested that someone else should be asked to do it!

It is quite true that the ordinary routine work of the Corps is not a very inspiring theme to write about, but behind all work always stands the man. I do not propose to say much about his work but only a little about Lewin himself and his family.

Retiring over 30 years ago Lewin's name is not likely to be known to many officers still on the active list of the Corps, the number of his surviving contemporaries is small, and his work had nothing very distinctive about it. But we cannot all be among the select "tenth" who make their mark and I think that a short account of Lewin's services and a few kind words about the man himself may fitly find a place in our *Journal*.

The Lewins are an old Kentish family who have lived for generations at Bexley and Eltham in Kent and their names are to be found in county histories and on monuments in Bexley Church.

Henry Frederick Chapman Lewin was the son of Henry Lewin (1802—1890), M.A., of Eltham, Kent, and of Mary Wray, his wife, a first cousin of the late Lieut.-General Henry Wray, C.M.G., R.E. Born at Eltham on the 2nd May, 1839, he was sent as a small boy to Mr. Thomas Hopkirk's preparatory school for Woolwich, Sandhurst,

Digitized by Google

and Addiscombe in that same country village, as it then was, and when he was old enough, was there specially prepared for the entrance examination to Woolwich. Those were the days of nomination and not of open competition. All who were nominated had to attain a certain standard for admission to the Royal Military Academy and the competition was limited to the place to be taken among those who qualified.

I well remember Lewin as a schoolfellow, but he was two years older than I was and, therefore, much senior to me in the school. It was then the time of the Crimean War and Lewin passed into Woolwich Academy, first of his batch, towards the close of 1854, I think. I can recall his coming over from Woolwich on a Sunday afternoon to see his old school and schoolfellows in all the glory of his first uniform as a gentleman cadet and how his old friends crowded round to admire and to ply him with questions about his Woolwich life.

He did well at Woolwich and was gazetted a lieutenant in the Corps on the 21st June, 1856. He was third in a batch of five Engineers, of which Major-General F. B. Mainguy was the head. He and Colonel A. G. Durnford are the only survivors.

After the usual courses of instruction at Chatham Lewin was sent in 1857 to Aldershot, whither Mainguy had already gone, and served there until April, 1859.

From Aldershot he sailed in May, 1859, to Malta, where General Sir Gaspard Le Marchant had recently succeeded Major-General Sir William Reid as governor, and he remained there for five years returning home in January, 1864.

After some six years in the Home District during which he was promoted to be captain on the 22nd December, 1865, Lewin was selected for an instructorship in fortification at the Royal Military Academy at Woolwich in August, 1870. He was on the staff of the Academy for over three years and during this time the French Prince Imperial and several officers of the Corps who afterwards became distinguished—among whom may be mentioned Field Marshal Lord Kitchener of Khartoum—were among his pupils. Colonel E. M. Lloyd, who was a fortification instructor at the Royal Military Academy for about a year with Lewin, writes:

"He was an excellent draughtsman so that his plates (*e.g.* the Antwerp front) could be hung up as models setting a high standard to the cadets. I never heard him lecture, and I don't know that he took much interest in the subject outside the course, but he was a good instructor."

It was while he was employed at Woolwich that he married, on the 25th February, 1873, at St. James's, Piccadilly, London, Mary Anna Eliza Grote, daughter of Arthur Grote (1814—1886), a distinguished member of the Bengal Civil Service (see *Dictionary of*

Digitized by Google

National Biography) and President of the Asiatic Society of Bengal (1859 to 1862, and again in 1865), by his wife, Mary Howel, daughter of Ilted Howel, a member of an old Welsh family. Another daughter of Ilted Howel married Mr. Robert Ellis Cunliffe, eldest son of General Sir Robert Henry Cunliffe, 4th baronet, and grandfather of the present baronet, Sir Foster H. E. Cunliffe.

The families of Lewin and Grote were doubly connected, for Arthur Grote's elder brother was George Grote (1794—1871), F.R.S., D.C.L., LL.D., the historian of Greece, M.P. for the City of London (1832—1841), who took an active part in the agitation for parliamentary reform, and was Vice Chancellor of London University (see *Dictionary of National Biography*). He married Harriet Lewin (1792—1878) daughter of Thomas Lewin (1753—1843), who was a first cousin of Lewin's father, by his wife, Mary Hale, daughter of John Hale, of The Plantation, Guisboro'. Harriet Grote was a lady of great vivacity and conversational powers, an accomplished musician and authoress. She wrote the lives of Ary Scheffer, the painter, and of her own husband, the historian, and is accorded a separate notice in the *Dictionary of National Biography*. She was thus on both sides a relation of Mrs. H. F. C. Lewin and a close intimacy existed between them.

Lewin was promoted to be major on the 26th August, 1873. In the following November he was moved from Woolwich to the Chatham District on promotion. Colonel J. W. Lovell, C.B., was his Commanding Royal Engineer until the end of 1874, when Colonel (afterwards Lieut.-General Sir) John Stokes succeeded him, but held the post for less than a year taking up the appointment of Commandant of the School of Military Engineering in November, 1875. He was succeeded by Colonel J. C. B. de Butts and under him Lewin served during the rest of the time he was stationed at Chatham, occasionally acting as Commanding Royal Engineer.

While stationed in the Chatham District Lewin lived first at Rochester and afterwards at Rings Lodge, near Wouldham, when he had charge of the land forts, extending from Borstal to Horsted, in course of construction by convict labour for the defence of Chatham Dockyard.

It was in 1877 on my return from service at Malta that I met Lewin again for the first time since our cadet days. Interested in his work, especially the defence work, and assiduous in the performance of his duties, he equally enjoyed his recreations. He was a skilful archer, a fairly good cricketer in his younger days, playing in some of the R.E. and West Kent matches, and an excellent racket and billiard player; indeed he retained his skill at billiards to the close of his life. He was also a keen musician, playing both the violin and violoncello.

Lewin enjoyed society in a quiet way and at Rochester Mrs. Lewin gave musical parties, at which by their own musical gifts they

Digitized by Google

were able to enhance the pleasure of their entertainments, while it is needless to say that they were themselves most desirable acquisitions at the musical parties of their friends. An old friend who knew them well in those days and kept up his friendship to the end of their lives, Dr. J. V. Bell, of Rochester, writes :

"My chief knowledge of the late Lieut.-Colonel Lewin was in the earlier years of his married life during his residence in Nile Terrace, in the house now occupied by General Sir Francis Thomas, Royal Marine Light Infantry, and afterwards at Rings Lodge, near Wouldham. Mrs. Lewin was a niece of George Grote, the historian, and Mrs. Grote used to come and stay with them and they had many friends in common especially in literary circles. Colonel and Mrs. Lewin were both very musical. Her piano and his 'cello found frequent employment in the quartettes which were a great delight to them, in a group which was mainly completed by musical members of the Corps. They were always present at any good concerts in the neighbourhood and gave their patronage and support to all local efforts for the advancement of music among the inhabitants. In addition to his refinement and culture Colonel Lewin was noted for his great kindness and consideration towards all who came in contact with him. Mrs. Lewin was delicate for many years and he seemed to think of everything which could be of any advantage to her."

In the summer of 1879 Lewin was moved from Chatham to Athlone in Ireland and in the following January to Woolwich. It was on account of his wife's health that he then decided to retire on a pension as a major with the honorary rank of lieut.-colonel, which he did on the 22nd May, 1880. After retirement he resided in London at 6, Ovington Gardens, S.W., until the summer of 1891. In the autumn of 1892 he went to live at Ovingdean, Bournemouth, Hants, where he passed the rest of his life.

Lewin was not what is called a reading man, but he occupied the spare time at his disposal by one of his hobbies of carpentering, printing, etc., and in doing what he could to benefit those about him. His old-world courtesy to all with whom he came in contact, his charm of manner and straightforward character gained him the esteem and affection of all classes. If he was not a great reader, he thought much on many subjects and his shrewd common sense was apparent in his conversation. Holding decided views himself he was yet most tolerant of the opinions of other people and was always willing to give his advice when sought, but not otherwise.

He joined the Royal Toxophilite Society in 1868, was honorary treasurer from 1882 to 1892, and vice-president from 1892 to 1895. Though an uncertain shot he made many good scores at the Public and other archery meetings which he always attended when possible. Perhaps his best performance was at the Grand National Meeting at Doncaster in 1878, where he won the medal for the 6th gross score of the whole meeting. He was Honorary Secretary of the Grand

Digitized by Google

National Archery Society. From 1881 to 1883 he was honorary secretary of the Crystal Palace Archery Meeting and, in 1896, he succeeded the late Major C. H. Fisher as honorary secretary of the West Berks Archers, resigning that office in 1909. He contributed occasional papers to the *Field and Archers' Register* on archery subjects, and was a recognized authority on this pastime (see *Badminton Library*).

During the years he lived at Bournemouth, Lewin did a great deal of quiet public work. He took especial interest in the Royal National Sanatorium, and was an active member of the Committee of that institution from 1893. Owing mainly to his influence a successful meeting of the Grand National Archery Society was held at Bournemouth on the Dean Park Ground when he acted as local secretary. At the same place in July, 1900, he pioneered the annual meeting of the Grand Western Archery Society. He interested himself in local questions and served on the committee of the Bournemouth Residents' Association for several years and also on the Board of the Income Tax Commission.

Mrs. Lewin died at "Ovingdean," Cavendish Road, Bournemouth, on the 20th May, 1909, and was buried in Bournemouth Cemetery.

From several brother officers and friends comes the same story, the loss of his wife completely broke Lewin down. Dr. Bell says :

"Two or three years ago she died, almost suddenly, just after she had completed the rearrangement of a very pretty garden behind their house in Bournemouth, and it was sad to see how terrible to him was the blank which was left by her removal. He seemed to have looked forward to some happy declining years in her society, but her death appeared to have taken away all desire for the prolongation of his own life. He just brightened up for the time to give my wife and myself the *kindly* welcome to which we had been accustomed many years before, but we could see that the charm of his life was gone, and we missed the dry humour which used to be so characteristic of him."

Lieut.-Colonel H. F. C. Lewin did not long survive his wife. He died suddenly of heart failure, at his Bournemouth residence on the 19th April, 1911, aged 72 years all but a few days. He was buried at Bournemouth beside his wife.

There was only one child of the marriage, a son, Henry Grote Lewin, born in Rochester on 4th January, 1874, who, after education at Clifton College, and Trinity College, Cambridge, entered the service of the North-Eastern Railway Company and is now at York as Mineral Train Superintendent of that system.

A local paper wrote of Lewin :—

"In the death of Colonel H. F. C. Lewin, R.E., at Bournemouth on the 19th ult. there passed away one, who after giving the prime of his life to his country, spent his later years in rendering services to the town

Digitized by Google

of his adoption, which were none the less efficient because they were quietly and unostentatiously performed.

. . . Himself a keen musician and a fine performer on the violoncello, he took the greatest interest in the rendering of classical music at the Winter Gardens, and was a constant attendant at the Symphony Concerts as long as his health permitted. His loss is felt deeply by a wide circle of friends and acquaintances."

Colonel Sir Duncan A. Johnston, K.C.B., wrote of his old and valued friend:

"I knew him first many years ago at Chatham when he was a major and I a young subaltern. He was very kind and friendly to me and I learnt to appreciate his sterling good qualities. He never pushed himself forward but was a first-rate officer, a good sportsman, and a genuine and true friend."

"I wish," writes Major-General F. B. Mainguy, "that I could tell you more about my old friend Lewin. He followed me to Aldershot from Chatham in 1857, but we were not long together there; and I only had an occasional glimpse of him from time to time while he remained in the Service. We renewed our acquaintance a few years ago when he came over to Guernsey one summer with his wife. We were both young fellows together at Woolwich and Chatham and were very friendly. He was, I always considered 'religious' and with high principles."

Digitized by Google

TRANSCRIPTS.

AN ELECTROLYTIC A.C.-D.C. TRANSFORMER.

(Taken from the *Kriegstechnische Zeitschrift*).

SEARCHLIGHTS, accumulators, galvanic baths, mercury vapour lamps and Röntgen ray apparatus normally require D.C. electricity for their working; the electricity supplied by the majority of power stations is A.C.; hence can be easily seen the need of an inexpensive and permanent transformer, to use the town supply for the more household purposes above mentioned.

The Siemens & Halske Allgemeine Gesellschaft have recently placed on the market an electrolytic A.C.-D.C. transformer, the low price of which (£6) compares favourably with that of the more cumbersome rotary transformers, and which is also superior to them as regards simplicity of handling and construction.

The principle of this transformer is as follows:—

"If one or more electrolytic cells be inserted in the circuit of a simple alternating current, the A.C. curve is flattened towards the abscissa axis (see *Fig.* 1).

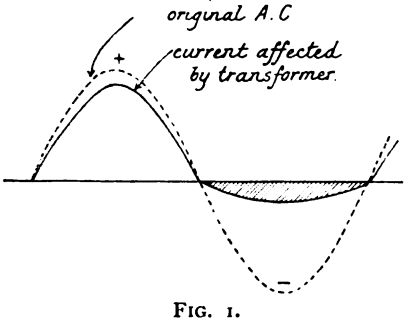


FIG. 1.

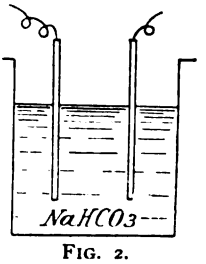


FIG. 2.

The action of such cells, which consist of two different electrodes in a liquid electrolyte (see *Fig.* 2) is to break up the alternating current attempting to pass through them, *i.e.* one pulsation, say the positive one, is but weakly affected by the counter E.M.F. and internal resistance of the cell, whereas the negative pulsation is reduced to the minimum possible, the net result being that the issuing current is practically a D.C. one."

Fig. 3 shows the actual transformer. Only two electrolytic cells are employed, the one in parallel with the machine (A) using the direct current, the other in series with this machine; it will further be seen that these cells oppose one another.

Digitized by Google

The cells consist of two plates: Aluminium (+) and iron (−) in a 5 per cent. to 10 per cent. solution of $NaHCO_3$.

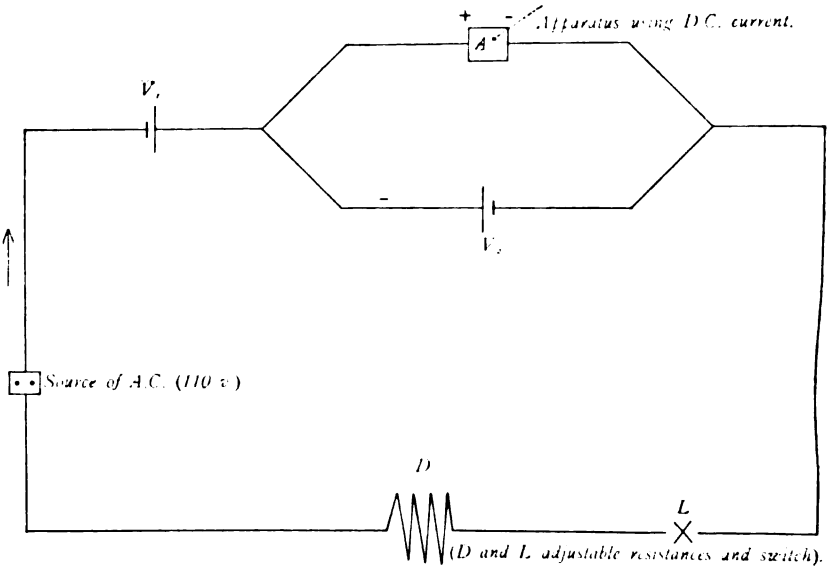


FIG. 3.

"D" and "L" are inserted resistances (glow lamps), by means of which the D.C. can be adjusted and kept as regular as possible (see *Fig.* 4). With an A.C. of 110 volts, the D.C. available at A varies from 65 to 75 volts.

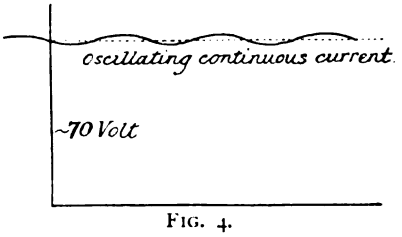


FIG. 4.

The action of the transformer is that the positive pulsation passes almost entirely through the cell V, whereas the negative is reduced to the small quantity shown shaded in *Fig.* 1. This minimum is allowed to pass through by the cell V_2 which only affords a path to negative pulsations. The positive pulsations do not attempt to pass through V_2 as the resistance of the path through A is infinitely the lesser.

As regards the military and naval applications of this instrument, it is suggested that it can be used to connect accumulators or searchlights direct on to the mains of town supplies, or to the large lighting plant of warships, and thus not only avoid the use of separate engines or rotary transformers for these apparatus, but also save the cost of the *personnel* required to attend to these machines.

A. H. SCOTT.

Digitized by Google

AUTOMATIC LAND MINES AT PORT ARTHUR.

From an article by L. Delvogori-Mokrievich in the December, 1910, number of the *Injenerni Jurnal.*

The Charge.—For the automatic mines, for the sake of lightness and convenience of handling, the charges were fixed at 1 *pūd* (36·11 lbs.) and the explosive used was gunpowder from the Chinese war loot of 1900.

The receptacles were made double, the inner cases being kerosene oil tins, 14″ in height by 12″ square, and the outer cases of wood as shown in *Fig.* 1. Their sides were of planks laid horizontally, held in place at the corners by outside and inside vertical battens, the latter of which served as supports for the second of the three lids. The bottoms were also made of plank, with a cross of battens laid on the inside.

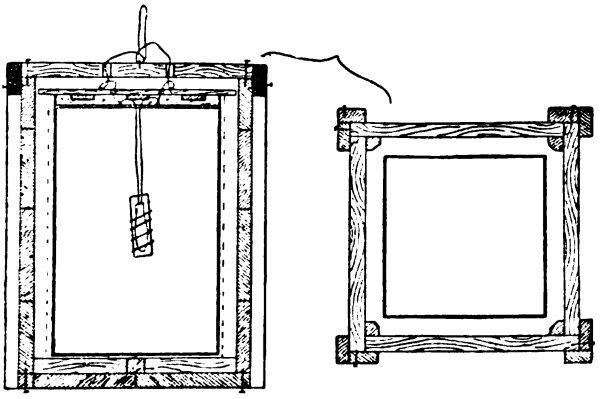


FIG. 1.

When an outer case was ready for the reception of an inner one a mixture of asphalt and pitch was poured into it until the cross battens at the bottom were covered. As soon as this had set the inner case, which had been previously filled with sand, or better still with stones, to prevent it from collapsing inwards, was placed carefully inside, so that the space between it and the outer case was equal on all sides, and this space was then filled with the composition. When this had set the inner case could be emptied and prepared for charging, but it could not be left empty in the heat of the sun without collapsing inwards.

The receptacle being now ready for charging, the tin was filled with powder to a height of 13½″, and covered with an inner cardboard lid with a single opening for the leads, the fuse having been fixed in the middle of the powder in the usual way. The rest of the tin was then filled up with sawdust, and the second lid, in which were two openings for the leads, was nailed over the whole interior space of the outer case.

Digitized by Google

Above this was poured a thick layer of composition, and finally planks forming the outer lid were nailed over all. The outside of the receptacle was painted with composition made without sand, and the leads, where they emerged from the openings in the cover, were made fast to small staples and then coiled with their ends insulated.

The Trap.—The *trap*, which is shown in *Fig.* 2, consisted of a square frame with a cover resting on interior springs, which could be pressed downwards if trodden upon, and from the underside of which was suspended an electric contact-maker. In general features the trap was similar to that given in the existing textbooks, but, from some experiments which had been carried out in 1903 by the Kwantung Sapper Company, during their summer course of instruction, certain faults had come to light for which at that time there had been neither time nor materials for finding remedies.

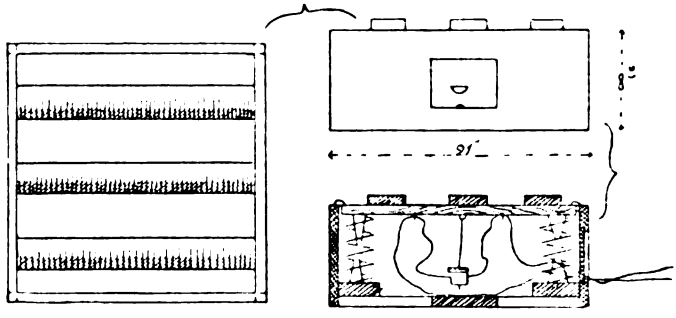


FIG. 2.

In 1904, by orders of General Kondratenko and Lieut.-Colonel Krestinski, further experiments were made by the author, with the result that (i.) a loose leather covering was nailed over the gap between the cover and the sides of the trap, in order to prevent earth from falling in and clogging the action, (ii.) a "window" was made in one side of the frame to allow of adjusting and testing the contact-maker without disturbing the trap, and (iii.) the size of the frame was reduced from a square of 28" to one of 21", as it was found that with the larger trap a man treading on one corner of the lid would only raise the further one without lowering the centre, from which the contact-maker was suspended.

The sides of the frame, which were 8" deep, were made of ¾" planks, and the bottom was a cross of battens, left open in order not to hold water. The top was of continuous planking, strengthened by cross fillets. At the corners on the wooden cross which formed the bottom of the trap, blocks were fixed to support the springs. This was done partly to economize the steel wire used in the springs, of which the supply was limited, and that very expensive, and partly because the shorter the springs the less liable were they to bend or get out of place. Wooden cores were also fitted to both blocks and lid to keep the springs in position

The "window" in the side of the frame was closed by a sliding shutter, and an opening was left in its lower edge through which the leads were carried to the contact-maker.

Digitized by Google

The springs were made of steel wire bent into a spiral. The gauge of the wire, the length, diameter, and grade of the spiral were arrived at after a series of experiments, the results of which have been unfortunately lost. The springs must be strong to prevent the trap being affected by light accidental blows. A method of testing them is shown in *Fig.* 3, the weight used and the required length of compression, x, having been decided upon in the course of the experiments. The springs and the rest of the traps were made by the fitters and carpenters of the mining detachment.

Contact-Maker.—The contact-maker is not described, as it was similar to that authorized in the existing manuals, but it appears to have consisted of a copper vessel suspended by a cord from the centre of the underside of the cover of the trap. On its underside was a needle which when the vessel was lowered struck the bottom cross of the trap, and caused the vessel to tilt, disturbing a copper pea-ball which rested in a hollowed plate and thereupon made contact between the plate and an inner ring in the contact-maker.

The following defects were discovered in the service pattern:—

(i.). Insufficient weight, which caused the vessel to be diverted from its position by the stiffness of the leads.

(ii.). The hollow of the plate was too deep, requiring too great tilting to release the pea-ball, so that the trap might be lowered and released without making contact.

(iii). The contact-maker was not waterproof and damp was found to penetrate into it through various openings.

These defects were remedied as follows:—

(i.). The contact-makers were made more heavy. The cases had formerly been made of copper tubing but General Kondratenko now arranged to have them cast in copper in the dockyard. The leads after passing into the trap through the opening in the shutter, were now made fast to screws on the underside of the cover, from which they passed with so little slack to the contact-maker that they brought little pressure to bear on it.

(ii.). A shallower design of bottom plate was arrived at after many experiments.

(iii.). All the openings in the contact-maker were closed with rubber solution and tape. But it was not found possible to entirely prevent damp from penetrating into the vessel.

(iv.). For suspending the contact-maker, gut was found to be the best material, as it did not twist and its length was unaffected by damp or temperature.

The plates, pea-balls and inner rings were electro-plated with silver.

Details Influencing the Sensitiveness of the Apparatus.—The sensitiveness of the apparatus was influenced by the following:—

(i.). The shape of the hollowed plate.

(ii.). The diameter of the pea-ball.

(iii.). The length of the gut.

(iv.). The vertical length of the vessel itself and the needle below it.

(v.). The strength and sensitiveness of the springs.

Digitized by Google

The degree of sensitiveness required was such that a weight of 4 pūds (144 lbs.) rapidly pressing on the cover of the trap should cause a contact long enough to ensure the raising of the temperature of the bridge of the fuse to a red heat.

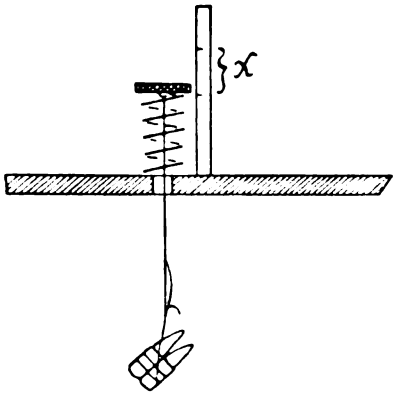


FIG. 3.

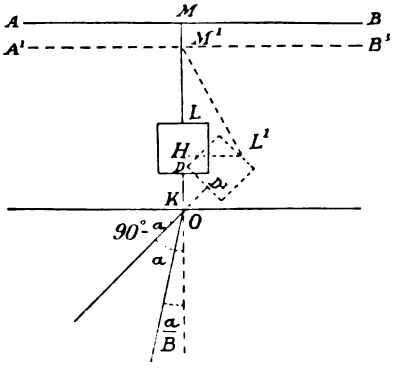


FIG. 4.

Before experimenting on the details of these requirements, it was decided to calculate the theoretic data affecting them. In *Fig.* 4, we will consider that a man stepping on the trap presses down the cover from the position AMB to A'M'B'. The point of the needle passes through the distance KO and is then stopped by the bottom battens of the frame, and the vessel tilts through the angle α. We will suppose that contact is made when it has tilted through the angle $\frac{\alpha}{\beta}$, so that while the vessel is being tilted from $\frac{\alpha}{\beta}$ to α and back to $\frac{\alpha}{\beta}$ the bridge of the fuse is being heated. The size of the angle $\frac{\alpha}{\beta}$ depends upon (i.) the length of KO (ii.) the curve of the plate and (iii.) the diameter of the pea-ball.

The size of the pea-ball was left unaltered. As the more KO is reduced the more sensitive is the apparatus, it was made as small as possible, always allowing the needle to swing clear of the cross battens. The uniformity of the bottom plates was secured by stamping them on a steel pattern which was made as the result of the experiments already mentioned.

The calculations show that the relation of MM' (h) with ML (m), LK (a) and the angle α is as follows:—

$$h = m + a + \mathrm{KO} - a \sin \alpha + \sqrt{m^2 - a^2 \cos^2 \alpha}.$$

m must be greater than $a \cos \alpha$, and it will be seen that if the vertical length of contact-maker and needle is made very great and the gut very short the vessel will not tilt sufficiently to reach the angle α or even $\frac{\alpha}{\beta}$.

If h is made very long a man passing very rapidly over the trap might not press it down far enough. If the springs are made weak then sometimes they might not remain extended. A very small h might not allow

Digitized by Google

long enough contact to fire the fuse. If *m*, *a* and KO are reduced then *h* must also be reduced proportionally. KO may be taken *a*2*mm*. The limit to which *a* may be reduced is found from the equation. A very short needle with a wide contact vessel might not allow the latter to tilt to the required angle and a very long needle might cause the vessel to upset. Therefore for a given size of contact-maker, *a* is constant.

As shown above *m* cannot be reduced beyond a known limit. Neither should it be increased beyond a limit fixed by the convenience of tying the gut and testing the contact-maker through the "window" in the side of the frame.

Originally the frames were tarred, but later on this was omitted for want of time, though when tarred the frames were less conspicuous for night work close to the enemy.

The Electric Battery.—The cells which were available for use with these mines were of various kinds, but most of them were of the "Hambourg" type, large and small, the former of which were used for firing the charges and the latter for testing. There were also 50 dry cells which were made up locally in the dockyard, and some others of a type which was apparently nameless.

In order to preserve the cells, and especially the Hambourg ones which were of glass, from damage and damp during transport, storage, fixing, and when left in the ground, they were fitted each into a strong wooden case and packed tightly with sawdust. Seven foot lengths of cable were soldered to the electrodes and brought through the outer lids of these cases and made fast as usual to staples on the outside.

In the latter end of March a series of experiments was carried out to ascertain the number of cells required to fire the mines. The cable available was taken from the Chinese War loot of 1900, and was 7-cored, the fuzes were two types of platinum fuse made by Messrs. Clarkson & Co., No. 1 being distinguished from No. 2 by having the picture of a lion on the case.

The experiments showed that (i.) No. 1 type of fuse could be exploded by one large Hambourg cell through a circuit of 700 yards of the Chinese cable, or, through a contact-maker, through a circuit of 115 yards; that (ii.) No. 2 type required a stronger current and was more suited to be used with Clarkson's exploder; and that (iii.) only one fuse could be fired at one time by means of the cells without very largely increasing the size of the battery.

From (ii.) it was decided that a group of four contact-makers and four charges could be worked by one cell, and yet be placed at sufficiently wide intervals to avoid the probability of simultaneous contact in two or more contact-makers.

The Groups of Mines.—The mines were consequently laid in groups of 1, 2, 3 or 4, in parallel, fired by a single battery (see *Fig.* 5). The "nets'

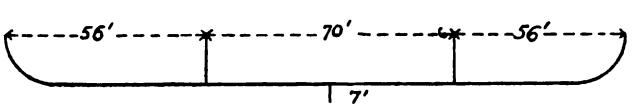


FIG. 5.

Digitized by Google

of cable were made up in readiness beforehand and a reserve was kept in case of necessity. All joints were welded, cleaned and insulated. As will be seen from *Figs.* 5—9, all the groups were designed so that the internal resistance of each was small for a single cell.

The necessity for having some reserve of electric power was due to the following causes :—

(i.). The contact-makers were found to get dirty from the damp and this increased their resistance.

(ii.). It was necessary to take into consideration the leakage of current due to the imperfect insulation of the cable.

(iii.). The gradual exhaustion of the cells due to this leakage which was largely increased by the frequent showers.

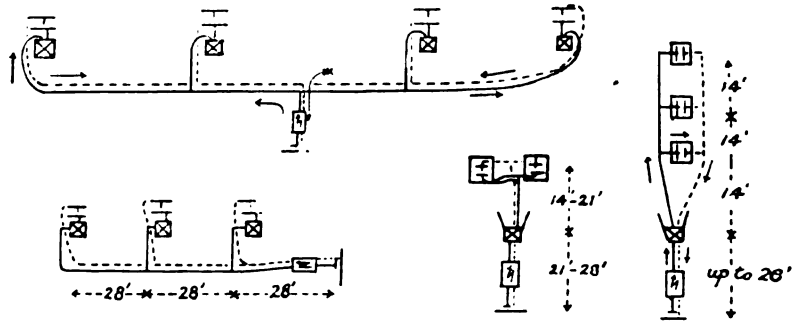
(iv.). The very short period of time during which contact would be made by an enemy stepping on the trap.

The end leads of each group were made very short —not more than 7'— as it was not intended to use any group more than once.

Disconnecting Boxes.—In every case a disconnecting box of the form described in the article on Observation Mines (see *R.E. Journal*, February, 1911) was placed in connection with each firing battery. Its object was to enable the mine to be put into a condition of safety during tests or repairs to the traps, etc.

The positions of the disconnecting boxes were always marked on the ground by a special arrangement of stones, etc.

Details of the Various Groups.—*Figs.* 6, 7, 8 and 9 show the general arrangement of the various systems of automatic mine obstacles.



FIGS. 6, 7, 8, & 9.

INDEX.

Cell.

Trap with contact-maker.

Charge.

Disconnecting box.

It will be seen that there were two distinct classes :—

1. Ordinary mines.
2. Fougasses.

Digitized by Google

In the case of the latter, in view of the considerable amount of labour involved in making the fougasses, and with the desire to mine a large area, it was usual to fit two or three traps to each fougasse.

The Cable Trenches.—For concealment, the cables were buried to a depth of 8″ to 16″. As the mines were always laid at night, in close proximity to the enemy, and outside the Russian firing line, it was not possible to do more than this. In this work the experience gained by the miners when concealing the cables of observation mines, before the close siege commenced, was invaluable.

The Chambers.—*Fig.* 10 shows in plan and section a chamber for an ordinary mine and trap. In order to save labour both were included in one excavation, with the trap towards the enemy. In the case of fougasses the traps were placed further to the front, in order to secure a larger field of action. The fougasse chambers were similar to those shown in the article on observation mines.

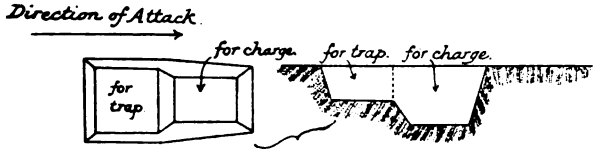


FIG. 10.

The Mine Laying.—The party detailed for laying a group of automatic mines consisted of one or two electricians and an unskilled working party. During the daylight a complete "net," together with charges, traps, etc., was taken from the Mine Laboratory to the district headquarters; at the approach of night it was carried on in the same carts to the firing line and there unloaded. A group of four mines required two carts, and one of two fougasses with four traps required four carts.

Beyond this they were carried forward by hand. Sometimes it was possible to push beyond the outlying sharpshooters, but often it was not possible, on account of the nearness of the enemy, to work much beyond the outpost line.

First the sites of charges and traps were decided upon, and then in accordance with the results of this reconnaissance the "net" was unrolled on the ground and the cables themselves acted as tracing tapes. The mines were then laid and the final connections made in accordance with the system decided upon, the last operation of all being that of fixing the plug in the disconnecting box.

With fougasses (see *Figs.* 8 and 9) the disconnecting boxes were placed 15 paces in rear of the fougasses, so that an accidental explosion should not injure the man operating the plug.

The occupation of laying a group of fougasses took from four to six hours, and that of laying a group of ordinary mines from two to four hours, depending on the nature of the soil and the size of the working party.

On two occasions the enemy temporarily stopped the work of mine-laying:—(i.) on the night of 6th—7th September in front of the Aqueduct Redoubt, and (ii.) on that of 28th—29th September in the ravine in front of the interval between Fort No. III. and Open Caponier No. 3. But in each case the Russians were able to complete the work during the same night.

Digitized by Google

There were occasions when mines had to be laid during the fighting, but for this advantage was taken of lulls, as the main conditions of success in the work are concealment and protection for the required number of workers. If the work could not be finished in one night the mine was discovered by the enemy at daybreak and destroyed. This also happened if he heard the sound of the work or blundered upon it in the darkness.

Reasons for using Electrically-Fired Mines.—The following are the reasons for choosing the electrically-fired mines of the kind described:—

(i.). Safety in laying. There was only one accident, on Long Hill.

(ii.). Facility in testing, repairing and disconnecting.

(iii.). Facility of concealment.

(iv.). Insensibility to water and damp. The contact-maker could be modified to preserve it absolutely from the penetration of damp, but the measures taken made it very nearly damp-proof.

(v.). Indifference to cold and frost.

(vi.). Insensibility to light blows from stones, or vibrations of the ground.

(vii.). Simplicity of construction, with the artificers available.

(viii.). Abundance of materials available for construction of traps, springs, contact-makers, etc.

(ix.). Safety of storing the several parts.

Tactical Application.—Automatic land mines may be laid:—

1. In front of the fighting line itself.
2. In places where it is not intended that our troops shall advance either in attack, sortie or by isolated sharpshooters.
3. In dead ground.
4. In places weakly defended by fire.
5. At points of probable attack, when rapid work is necessary.
6. In all cases when mining is desirable but when the want of men, electric batteries, or cable, preclude the use of observation mines.
7. In front of the enemy's sapheads.
8. In front of the salient angles of works.
9. In roads.
10. In abandoned works, houses, etc.

Their mutual siting is governed by the same rules as that of observation mines.

DETAILS OF AUTOMATIC LAND MINES LAID AT PORT ARTHUR IN 1904.

No.	Date.	Place.	Number of Mines, etc.	Object.	Result.
1	28th Mar.	In an advanced position to which Junior Under Officer Antonov was sent by order of Lieut.-Col. Jerebtsov.	Issued from the mine laboratory:— 10 charges, 10 traps, 5 'nets' of cables, 14 contact makrs.	Mining roads.	Never laid.
2	Night 26th–27th July during fighting.	In an advanced position in the nullah on the left flank of the 13th E. Sib. Rifle Regt.	12 charges, *i.e.*, they were carried on 12 carts.	In the valley weakly commanded by fire and the approaches to which were concealed. It was easy to advance up singly but in a line difficult.	During the fighting 26th to 28th July no advance took place here. It is not known if the enemy struck them after the position was abandoned.

Digitized by Google

DETAILS OF AUTOMATIC LAND MINES LAID AT PORT ARTHUR IN 1904—*Cont.*

No.	Date.	Place.	Number of Mines, etc.	Object.	Result.
3	5th–6th Aug.	In the ravine on the west slope of Angle Hill.	Mines (?) with cells of submarine mines.	To mine the approaches to the position. Ensign Berg with 4 miners.	They say that during the attack on Angle Hill a Japanese column was blown up.
4	18th Aug. by day.	Between 203-Metre Hill and Fort No. V. in 2 places.	6 ordinary mines in 2 groups.	Mining dead ground to protect 203-Metre Hill from being turned.	No information received. The enemy only reached here in December.
5	19th Aug.	Same place.	4 charges.		
6	24th–25th Aug. and other days three times.	In front of Redoubt No. I after a sortie.	4 charges.	To take the redoubt and then mine the approaches to it. By order of Lt.-Gen. Smirnov and Col. Grigorenko.	The task was impossible. They did not reach the redoubt and therefore never laid the mines.
7	Night 28th–29th Aug.	In front of wire entanglement in the nullah between Long Hill and 203-Metre Hill, opposite the Interval Hill.	2 fougasses and 4 mines.	To mine the ravine against an inroad of the enemy in rear of Long Hill.	No accurate details.
8	Night 2nd–3rd Sept.	Between Long and Division Hills.	6 mines in 2 groups.	To mine the dead ravines in front of a weakly defended part of the position.	No accurate details. At 12.30 p.m. on 23rd Sept. a mine was seen to explode.
9	Night 3rd–4th Sept.	Between 203-Metre and Long Hills.	2 mines.	To mine the dead ground in front of 203-Metre Hill.	?
10	4th Sept.	To 203-Metre Hill and Flat Hill.	7 cart loads.	Charges despatched.	—
11	Nights 5th–6th and 6th–7th Sept.	In front of glacis of Fort No. II.	4 automatic fougasses with 2 traps each.	To mine the dead salient angle against the enemy's advance.	In the night 10th–11th Sept. one fougasse was exploded by one of the enemy's sharpshooters and on 11th at dawn one was exploded by the bombardment.
12	Nights 6th–7th and 7th–8th Sept.	In front of glacis of Temple Redoubt.	7 mines in 2 groups.	Opposite the front face in the road of a former advance of the enemy.	No information.
13	Nights 6th–7th and 7th–8th Sept.	In front of the glacis of the Aqueduct Redoubt.	7 mines in 2 groups.	Opposite the front face and in the road of a former advance of the enemy.	On 19th Sept. between 4 and 6 p.m. a mine exploded under the enemy.
14	Night 8th–9th Sept.	Between 203-Metre and Flat Hills.	6 mines in 2 groups.	In dead ground.	No information.
15	Night 10th–11th Sept.	On the left slope of 203-Metre Hill.	6 mines in 2 groups.	To mine dead ground near the trench.	One mine exploded about half an hour after the miners left.

Digitized by Google

DETAILS OF AUTOMATIC LAND MINES LAID AT PORT ARTHUR IN 1904—*Cont.*

No.	Date.	Place.	Number of Mines, etc.	Object.	Result.
16	Night 12th–13th Sept.	In front of the glacis of Fort No. II.	1 fougasse with 2 traps.	To replace those exploded.	No information.
17	Night 13th–14th Sept.	Same place.	1 fougasse with 2 traps.	Ditto.	—
18	Night 13th–14th Sept.	Between Long and Dead Head Hills.	6 mines in 2 groups.	In the road of a probable and early attack.	According to report they exploded in the night of 20th Sept. and at 2 p.m. on 22nd Sept.
19	Nights 19th–20th Sept.	In front of Aqueduct Redoubt.	2 mines.	To replace exploded ones.	No information.
20	Night 21st–22nd Sept.	To left of Fort No. II.	2 mines.	In dead ground.	Unknown.
21	Night 24th–25th Sept.	In the valley of the Lunho. In front of the Crematorium enclosure.	6 mines in 2 groups.	In dead ground.	No information.
21 (*sic*)	Night 25th–26th Sept.	Same place.	6 mines in 2 groups.	Ditto.	Unknown.
22	Night 27th 28th Sept.	Same place.	6 mines in 2 groups.	Ditto.	Unknown.
23	Night 28th–29th Sept.	In nullah between Fort No. III. and Open Caponier No. 3.	4 mines in 1 group.	Dead ravine in road of enemy's advance.	During the laying an attack by a small party was beaten off. After laying one exploded. The enemy took away the charges.
24	Night 10th–11th Oct.	In front of Battery Letter B.	2 fougasses with 2 traps each.	Approaches to the position. Changed from observation mines as the cables were badly damaged.	In the night 23rd–24th Nov. during the attack one fougasse exploded. The attack was renewed only after half an hour.
25	Night 12th–13th Oct.	In front of Battery Letter B.	3 fougasses with 2 traps each.	To mine the approaches.	Ditto.
26	Night 13th–14th Oct.	In front of Signal Hill in Small Bay Ta-Ho.	4 mines in 1 group.	In the road of a previous advance.	No information.
27	Night 19th–20th Dec.	In front of the salient angle of Tumulus Battery.	3 mines in 1 group.	In dead ground, in the road of a former attack by the Japanese.	There was no advance here.

F. E. G. SKEY.

Digitized by Google

THE ENGINEERS AT THE AUTUMN MANŒUVRES OF THE 20TH (FRENCH) ARMY CORPS IN 1910.

Two articles under the above title appear in the May and June numbers of the *Revue Militaire Générale*. The articles contain an account of the operations of the companies of the 20th Battalion of French engineers allotted to the Red side on the manœuvres, and the lessons which the writer deduces from them regarding the employment of engineers in the field and the training, organization and equipment requisite to fit them for their *rôle*. The bulk of these lessons, for us the most interesting feature of the articles, are collected together in the conclusions which follow the narrative of the operations.

The manœuvres were divided into three periods. During the first and second of these the Red force consisted of a division with a cavalry brigade and an additional battalion of chasseurs à pied, strength in all four infantry regiments and one extra battalion, three brigades of artillery, and two regiments of cavalry. With this force were two companies of engineers acting in the capacity of divisional companies. An opportunity was thus afforded of testing the projected provision for war of two companies to an infantry division of two brigades.

In the third period the Red force was organized in a division of four infantry regiments and two artillery brigades, and a mixed brigade of two infantry regiments, two battalions of chasseurs à pied and one artillery brigade. Two brigades of artillery formed the corps artillery, and there was a cavalry brigade, of two regiments. The engineer companies were allotted one as a divisional company and one as corps engineers.

For the purposes of the manœuvres each of the companies had been provided, in addition to its normal technical vehicles (three 3-horse tool carts and a light explosives cart), with a bridging wagon carrying trestles, baulks, cordage, chesses, and raft-bags. The material on each wagon was sufficient for the construction of a footbridge 1·50 metres in width and 14 metres long.

During the first period the Red force represented part of a retreating army and its special mission was to prevent if possible the passage of the Moselle by the enemy and in any case to delay his advance. This task the commander of the force proposed to carry out by taking advantage of the dispersal inseparable from the passage of the river to attack the enemy at a favourable time and place and to drive his main body back into the river.

No. 2 Company was allotted to a detachment consisting of two battalions, one battery and a squadron under the command of the commander of the infantry regiment. Three sections were each employed on the preparation for demolition of a bridge across the Moselle. The fourth had the task of preparing for defence a rallying position. The reconnaissance of the position was carried out by an infantry captain

Digitized by Google

assisted by an engineer lieutenant and the infantry co-operated in the execution of the works.

No. 3 Company was retained with the main body and was employed on the construction of bridges to facilitate the advance of the main body. For this purpose the bridging wagon of the other company had been temporarily attached to it. The bridging equipment proved insufficient and clumsy and the construction of the bridges took four hours. If only material found on the spot had been available still more time would have been required. To avoid delay in urgent cases engineer companies need a light bridging equipment designed for rapid construction.

The enemy having effected the passage of the Moselle on the first day the Red force continued its delaying tactics on the second day, the 9th September. No. 2 Company was detailed to prepare a village for defence to form the pivot of a delaying position. Pending the arrival of the infantry garrison the officer commanding the engineer company reconnoitred the village for tools and materials, and took immediate steps for its security. On arrival the infantry co-operated with the engineers in the execution of the defensive works. In the afternoon a verbal order reached the lieutenant commanding the company, from the G.O.C., directing him to proceed at once with his bridging equipment to a point where a local offensive had attained some success. The successful troops having been brought to a standstill by the time the engineers arrived, the necessity for the bridging did not arise but the company was at once set to work on measures to secure the ground already gained.

The other company was employed in the preparation for defence of two woods, as positions to fall back upon in case of necessity. This they had to undertake single-handed, no infantry being told off to assist in the preparations. On this occasion the time available sufficed to allow the company to complete the necessary works but the writer gives it as his opinion that as a rule, in field operations, clearances, abattis, trenches and the preparation of the edge of a wood on an extensive scale will be out of the question for a company of engineers. When in touch with the enemy the works that can be executed for the defence of a wood will be only very hasty and the principal function of the engineers will be the improvement and construction of interior communications.

During the progress of these works one section was withdrawn to organize, in conjunction with a company of infantry, the defence of a neighbouring village.

On the 10th September, the third and final day of the first period, the Red force was compelled to fall back. The two engineer companies were employed at different points on the preparation for defence of woods, farms, and villages.

At one of the villages no infantry were detailed to assist in carrying out the measures for defence. The writer of the articles takes the opportunity to emphasize the provisions of the official instructions, that engineers should intervene "in all circumstances which demand either the special technical knowledge which their *personnel* possesses, or the tools and equipment which they carry." This he reads as indicating that simple works such as ordinary trenches and the preparation of hedges, and enclosures should be carried out by the infantry, the engineers being

Digitized by Google

reserved for such work as the construction of loopholes in masonry, clearance of the field of fire and the construction of covered communications, shelters and barricades. The issue of the necessary orders for the execution and occupation of the defensive works is the duty of the commander of the garrison. Engineers may assist in the defence of a pivot but to detail them to organize and defend such a point is a misuse, and involves an unjustifiable risk of depriving the infantry prematurely of their services. At the same time it is better to employ the sappers as infantry than not at all.

The tool wagons (weighing 2,200 k.g.) drawn by three horses proved too heavy to negotiate steep slopes or bad roads. They were often unable to follow the *personnel* closely and were in consequence not immediately available when they were urgently wanted.

The advisability of breaking the company up into half-companies and sections, employed independently in different parts of the field, appears to be a question on which opinions differ among French engineer officers. The chief argument adduced against it is the loss of control by the captain commanding the company. The writer of the articles contends that efficient co-operation with the other arms will demand such dispersion on occasions, and that a better organization of the technical transport, and adequate provision for communication would minimize the evils attendant on it. In his view however the detachment of a section or half-company should only very exceptionally be for a period exceeding 24 hours.

The special idea in the second period was that the main Red Army (imaginary) was now in a position to assume the offensive. The Red force was to disengage itself from the enemy before it and to act in such a way as to cover the deployment of the main army.

On the first day reconnaissances were ordered to be made by engineer officers of a route, of a position, and of the passages of a river.

With this exception both companies were employed during this period solely on the preparation of villages for defence. In one case the object was to meet a hostile turning movement which was developing and, at the suggestion of the chief engineer's staff officer, corresponding to our adjutant R.E. in a division, two companies of infantry were detailed by the brigadier concerned to co-operate in the work.

The third period consisted of a general assumption of the offensive by Red.

Again the preparation of villages for defence, to serve as pivots of manœuvre, was an important feature of the work of the engineers but, as was to be expected in an advance, the need for bridges furnished them with several opportunities of rendering valuable assistance to the other arms. The advantage of having readily available even a clumsy bridging equipment, instead of having to rely solely on material obtainable on the spot was clearly demonstrated.

Conclusions.

Manœuvres do not give a very satisfactory idea of the employment of engineers on service. The absence of fire effect, the necessity of keeping within bounds claims for compensation for damage, and the extent to which existing passages over streams and rivers are used detract from the

Digitized by Google

value of the experience they afford. To these might be added the rapidity with which events move and fresh situations develop.

They do however give an indication of the *rôle* of the engineers in the field and a criterion for estimating their fitness to fulfil that *rôle*. The experience of the manœuvres under consideration convinced the writer of the articles that the French engineers are not in a position to render "in the shortest time and with the means at their disposal the services which the other arms will expect of them." In his conclusions he examines the reasons and remedies for this condition of affairs.

The principal services which the engineers can render to the other arms in field, as distinct from siege operations may be classified under three heads:—

(1) Those which facilitate the movement of the other arms,

(2) Those which strengthen their hold upon the ground that they have won or are endeavouring to deny to the enemy, and

(3) Those which assist commanders and their staffs in the fulfilment of their duties.

To the first class belong the construction of roads and communications and the improvement of those already in existence, bridging, and the removal of obstacles to movement. Mobility being one of the most essential factors of success in modern warfare services under this class may be placed first in importance among those which fall to the lot of the field engineer.

To the second belong the organization and preparation of localities for defence, to serve as rallying positions, *points d'appui*, or pivots of manœuvre.

In the performance of services under either of these two heads the work of the engineers should be carried out in co-operation with the other arms. Their numbers are of necessity small and, in order that they may be able to concentrate their labours on such tasks as demand the special technical knowledge and aptitude which they possess, the simpler tasks which do not demand those qualifications should be executed by the other arms.

In the defence of a locality the responsibility for the measures taken must rest on the officer who commands the troops detailed for its defence, and the general line of action should be defined and the orders for the construction and occupation of the works given by him. The engineer officers can assist him in this by technical reconnaissance and advice as to engineering measures for developing the facilities for resistance which the locality presents.

As regards the execution of the necessary works the principle of co-operation with a view to the economy of skilled labour must be applied. The infantry should dig the trenches or improve the natural cover which they will occupy and may construct simple obstacles, and the artillery should prepare their own gun emplacements, whilst the engineers, assisted where necessary by infantry working parties, will, in all probability, find full employment in such works as clearance of field of fire, construction of abattis, preparation of buildings for occupation, communications, particularly within villages, and any others which call for the special qualification which they possess or the special equipment which they carry.

Digitized by Google

Neglect of the principle that the officer commanding the garrison should give the order for the works to be executed may result in the engineers expending their time and labour on works which will never be occupied or utilized, and neglect of the principle of co-operation will almost inevitably lead to a failure to develop to the utmost, in the time available, the defensive capabilities of the locality. The manœuvres afforded instances both of the right and of the wrong way of employing engineers in preparing a defensive position.

Since time is an all-important factor in war, the training, organization, and equipment of the engineers should be designed with a view to rapidity in the performance in the field of such services as the other arms have a right to expect of them.

Delay may in the first instance be saved by foresight on the part of the commander and his staff, who should provide in their dispositions for adequate numbers of engineers being immediately available at any spot where a need for them can be anticipated.

A thorough knowledge of the tactics of the other arms is essential to the engineer officer to enable him to recognize at once and to seize any opportunity of assisting them in the execution of their duties. This and the powers of endurance necessary to ensure that the engineers shall not only be able to keep up with the other arms but shall at the end of the march still be in a condition to carry out the work required of them, can best be attained by exercises in conjunction with the other arms. The rudiments of their profession must be learnt on the fieldwork ground and at bridging schools and camps, but the time devoted to such instruction should be reduced to a minimum in order that more may be devoted to combined exercises. Such exercises besides developing powers of marching and imparting tactical training teach the application of the technical lessons learnt during the preliminary instruction.

The speedy execution of orders conveyed to the commanding engineer by the general commanding a division demands adequate provision for communication between the former and his companies. The writer advocates giving him in addition to his staff officer or adjutant two cyclist orderlies. Similar provision should be made within the company to meet the case of its dispersion in half-companies or sections.

This question of dispersion is, as already mentioned, much debated among French engineer officers. Its opponents fear that, if the company is organized and equipped so as to make sections self-contained, there is a danger of their permanent detachment to brigades or regiments. Except perhaps in the case of a small force detached to a distance and for some time such a course would certainly seem unjustifiable. Any distribution of the parts of a company should be made with a view to meeting some situation involving a probable call for their services. That such a distribution may on occasions mean a saving of time, consequent on technical assistance being available without delay, can hardly be denied and, if it be admitted, the organization and equipment of the engineer company to meet it follow as a logical conclusion.

The author of the articles suggests the inclusion in every field company of a cyclist or mounted detachment. When the company was ordered to carry out any task at a distance the cyclist or mounted detachment could

Digitized by Google

move, with an officer, in advance of the main body of its company and assist the officer in his reconnaissance or make a start on preliminary works, such as, in the case of a bridge, the approaches. Mounted men would have the advantage over cyclists of being able to move more rapidly, across country or by soft roads.

A propos of the dispersion of the sections of a company the writer outlines a reorganization of its technical vehicles so as to render the sections self-contained, which is interesting mainly because of its similarity to the organization of our own field companies. A feature of his proposals is the lightening of vehicles to ensure their being able to follow the *personnel* closely under all conditions. He advocates further the inclusion in the company of some light, handy bridging equipment. Each company would have nine bridging wagons, one for trestles, four carrying a half pontoon each (metal boats) and four carrying superstructure. This would enable each company to construct rapidly 35 metres of footbridge or 15 to 20 metres of medium bridge. The French like ourselves have organized their bridging material in bridging trains which the writer fears may often be inaccessible to meet a sudden call consequent on unforeseen developments.

Provision on the company vehicles for carrying the equipment of at least a section so that the men may arrive fresh for work at the end of a march, and arrangements for the carriage of light tools on the person so as to relieve the men from having to carry them long distances in the hand are also recommended.

The French recognize the growing demand for the technical services of engineers in the field and that an increase in the proportion of their numbers to those of the other arms is not in any sense to be regarded as a loss to the offensive strength of the army. The concentration of bridging material into bridging trains, the development of airships and the advent of aeroplanes as engines of war, and the more comprehensive provision for telegraphic and telephone communication have led to the abolition of corps engineer companies, but the increase of the number of divisional companies to two per division is projected.

General Langlois contributes a note at the end of the final article, in which he emphasizes the importance of time and the view that the chief mission of the engineers is the provision and improvement of communications. He strongly supports the contention that the first aims of the training, equipment, and organization of engineer companies for the field should be mobility and rapidity in the execution of their mission.

It would appear that in the matter of organization and equipment our field companies are, to some extent, more favourably situated than are the French engineers to meet the demands that may be made on them. In other respects, however, many R.E. officers will probably recognize a marked similarity between the difficulties with which the French engineer has to contend in the field and those which they have themselves experienced.

T. T. GROVE.

Digitized by Google

REVIEWS.

HISTOIRE ÉLÉMENTAIRE DE L'ARCHITECTURE MILITAIRE DEPUIS L'ANTIQUITÉ JUSQU'AU XVI[E] SIÈCLE.

Par ALBERT MERSIER, Membre de la Société Française d'Archéologie.

"THE writing of a universal history of the art of fortification from antiquity to our own day is one of the finest works possible for the archeologist," was the sentiment expressed by Viollet-le-Duc in his essay on medieval military architecture. The author of the present book further endorses this opinion by saying that fortifications have played such an important part in history that the art is well worthy of study. The value of ancient fortifications is brought home to us by the fact that the sites chosen for them have been approved of by so many successive generations, and that in many cases the work of our early ancestors has been continued and developed so as to meet the ever-advancing requirements of the art of war.

The first volume deals with fortification up to the end of the "classic" period, as the author expresses it, *i.e.* to the fall of the Roman Empire. The second volume carries us to the XVI. century, when the general adoption of gunpowder for artillery changed the whole art of fortification.

The book is divided into two parts. The first deals with the general methods of attack and defence, and the offensive and defensive weapons in vogue. The second part consists of a historical account of the development of the art of fortification as practised by the Egyptians, Mesopotamians, Persians, Carthagenians, Sardinians, Greeks, Romans, and Gauls. The works of the last two are divided into two categories: those made of some permanent building material, and temporary earthworks.

There are numerous illustrations and diagrams; and the text is enlivened by historical sketches and anecdotes. The descriptions of the fortifications of Susa, with its ditch 125 metres broad and its triple "enceinte," and of Babylon with its "enceinte" of 90 k.m., give us some idea of the stupendous works undertaken at these remote periods. The account of ditches filled with tigers, snakes, scorpions, and such like dangerous creatures, will, perhaps, appeal to the modern mind as strange. Perhaps the addition of a few dates would enable one to better appreciate the evolution of the art of fortification. The book has only about 200 pages and forms easy reading.

K. J. MARTIN.

Digitized by Google

REINFORCED CONCRETE CONSTRUCTION.

Reinforced Concrete Construction, Elementary Course, with examples worked out in detail for all types of Beams, Floors, and Columns by M. T. Cantell, Licentiate, R.I.B.A.; Associate, Surveyors' Institution; Head of Architecture and Building Department, Municipal Technical College, Brighton. Size $7\frac{1}{2}'' \times 5''$; pp. 125; illustrations 65. Price 4s. 6d. net. Published by Spon.

A concise little book written for students, as well as for those who have practical experience but only an elementary knowledge of mathematics and mechanics.

Simplicity—the aim of the book—has been nearly achieved. It contains principles, descriptions of materials and falsework, bending moment and shearing stress diagrams for cantilevers and beams supported and fixed in various ways under concentrated and distributed loads.

The main part comprises theory and examples of singly and doubly reinforced beams, slabs, tee beams and columns.

The calculations for shear and adhesion are clear.

The R.I.B.A. system of notation might have been adopted with advantage.

At the end are tables of squares, cubes and roots and various areas. If it is thought desirable to include figures which can be obtained from the ordinary engineering pocket-book a table that would better merit inclusion in this work would be one of areas, circumferences and weights of market sections of round steel bars.

The general description is clear and concise.

The bending moment diagram in *Fig.* 11 is incorrectly drawn, and the statement near the top of page 32 with regard to the lever arms being equal is confusing.

These inaccuracies may cause difficulties to those whose mathematical training is weak and for these the work is intended.

In the same connection it may be mentioned that the bending moment and shear diagrams for simple beams are plotted without any convention as regards sign, so that the derivation of the diagrams for the fixed and continuous beams is not so obvious as it might be.

On the whole we recommend the little book to those requiring a simple treatment for a first study of its subject.

The preface refers to an advanced course by the same author, but so far it has not been brought further to our notice.

Digitized by Google

RECENT PUBLICATIONS OF MILITARY INTEREST.

REVIEWS OF BOOKS.

[Reprinted from *The Army Review* by permission of the Controller of His Majesty's Stationery Office.]

* * * *

AERIAL NAVIGATION.

AVIATION IN THE ARMY AND NAVY AND IN THE COLONIES AND OTHER MILITARY QUESTIONS OF THE PRESENT DAY (L'aviation aux armées et aux colonies et autres questions militaires actuelles). By General H. Frey. 168 pp. 8vo. Paris, 1911. Berger-Levrault. 3s.

The author of this book will be remembered as the Commander-in-Chief of the French Expeditionary Force which took part in the march on Pekin in 1900.

Although the greater part of the book is devoted to the subject of aviation, a number of other questions which have no connection with this subject are sandwiched into it, without any apparent relevance, and are discussed at some length.

So far as aviation is concerned, the writer points out the advances which this science is making almost daily, and he gives his views as to the effect of the introduction of aeroplanes and dirigibles on naval warfare, and on the tactics of infantry, cavalry, and artillery. Attention is also drawn to the great advantages to be gained from the systematic use of aeroplanes and dirigibles in Algeria and French West Africa. General Frey suggests in this connection that a regular service of airships should be established as follows :—

(1). From the railway terminus at Biskra to Beni-Abbas.

(2). From Biskra to (*a*) Insalah and (*b*) Timassinine, the most southerly military posts in Algeria.

(3). From Insalah to Timbuctoo, and Timassinine to Agades, and then, if possible to Lake Chad.

He further recommends the construction of ports for air craft at Timbuctoo and Lake Chad, and the despatch of a number of airships to Wadai.

The author finally urges on the French Government the necessity for immediately constructing a large air-fleet, and appointing an inspector of aeronautics to deal with all questions relating to aerial navigation.

The other questions unconnected with aviation which are discussed in the book are :—

(*a*). The French umpire regulations. These do not satisfy the author, who proposes various amendments, among others the somewhat novel one that, with a view to modifying the severity of the comments of the umpire staff, umpires and commanders of troops should be made to change places at certain periods of the operations !

(*b*). The conferences held at the conclusion of manœuvres, which the writer contends are at present not carried out in accordance with the regulations.

(*c*). The visit of the President of the French Republic to the autumn manœuvres, which General Frey considers should never be omitted because of the encouragement given to the troops by the fact of the President being present at the manœuvres.

(*d*). The etymology of certain African names, such as Wadai, Tibesti, etc.

(*e*). The application of the law of universal service to the natives of Africa with a view to raising a large army of black troops which could be utilized either for relieving white troops for employment in France, or, in case of necessity, to aid the Home Army in the defence of French soil.

Digitized by Google

HISTORY.

THE FRENCH GENERAL STAFF ACCOUNT OF THE CAMPAIGN OF 1870–71. ITS TRUTH AND ITS ERRORS. Vol. X. Part 2. (Das französische Generalstabswerk über den Krieg 1870–71. Wahres und falsches). By Colonel E. v. Schmid and Colonel P. Kolbe. 111 pp., with 1 sketch map. 8vo. Leipzig, 1911. Engelmann. 3s. 6d.

Part 2 of this work is devoted to the French "Army of Châlons," and this volume deals with the movements of the French 13th Corps (Vinoy) between the 20th August and the 2nd September. As in previous volumes, the narrative is based on the French General Staff account of the operations, and this is critically examined by the authors.

ORGANIZATION AND ADMINISTRATION.

THE ORGANIZATION OF TELEPHONE DETACHMENTS, THEIR DUTIES IN BIVOUAC, ON THE MARCH, AND IN ACTION. By S. Agapov. 52 pp., with illustrations and diagrams. 8vo. St. Petersburg, 1911. Marks. 1s. 6d.

This little book is intended to supplement the instructions for the use of telephones contained in the Russian "Manual of Military Engineering for Officers of all Arms, 1910." Technical details of the apparatus are not dealt with, and the author confines himself to the consideration of the practical employment in the field of the material and *personnel* of a regimental telephone detachment. The method of laying cable is described, and various expedients for overcoming the difficulties of different kinds of ground are given. Several diagrams are provided to illustrate the tactical employment of the telephone with the regiment, on outpost duty, in action, on the march with an advanced guard, or in two columns on parallel roads. The descriptions are, however, rather short, and the book would be of greater value if this part had been expanded.

TELEGRAPHS AND COMMUNICATION.

TECHNICAL MEANS OF COMMUNICATION IN WAR (Die Verkehrs- und Nachrichtenmittel im Kriege). By H. Thurn. 278 pp., with index, and 32 illustrations and diagrams. 8vo. Leipzig, 1911. J. A. Barth. 6s.

The author, who is a Post Office official, states in his preface that his object in writing this book is to demonstrate the necessity for the existence in peace of a well-trained corps of communication troops.

The work is divided into twelve chapters and an appendix. Each chapter deals with a separate subject in a semi-technical manner, the headings being as follows:—Waterways, roads, and lines of communication; railways; motor vehicles; cycles; aeronautics; pigeon post; photography in connection with balloons and carrier pigeons; state telegraphy; field telegraphy; optical telegraphy; wireless telegraphy; field postal service. The appendix deals with orderlies on snowshoes and ski, the war dog, comparison of the strengths of the communication troops in various armies, and gives a list of works of reference.

The subjects are dealt with in an interesting manner and not too technically, so that it is possible for the non-expert reader to gain a very clear idea of the various means of communication, their advantages, and their limitations.

Digitized by Google

Digitized by Google

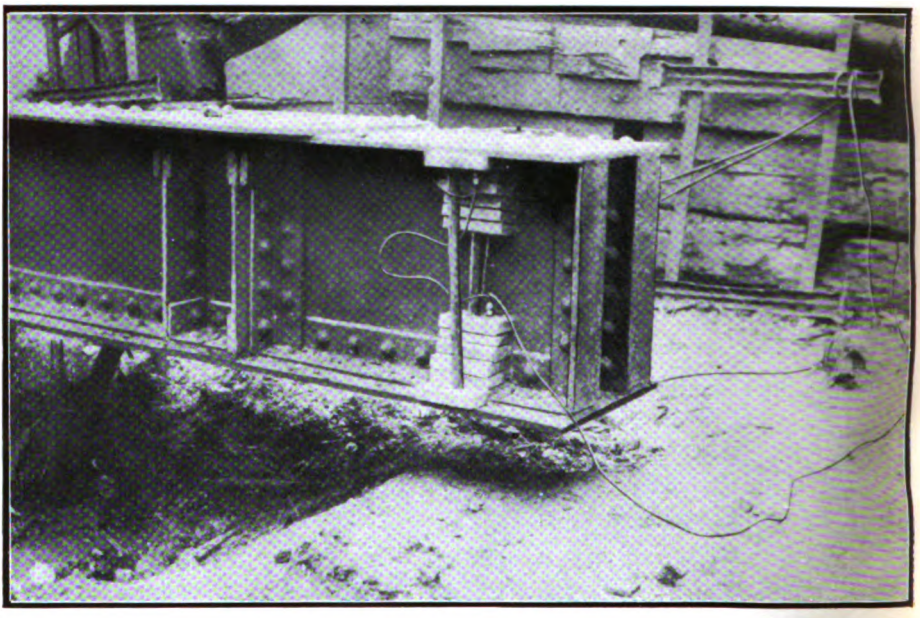


Fig. 21.

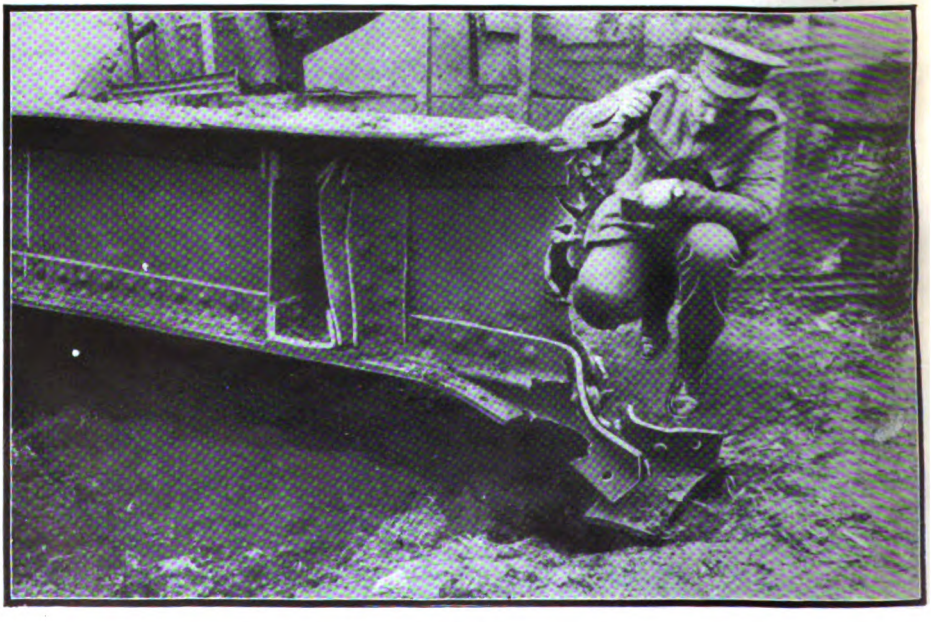


Fig. 22.

Digitized by Google

SOME NOTES ON FIELDWORKS.

By MAJOR J. C. MATHESON, R.E.

THE following notes are obtained from various sources, most of them being taken from the reports on the Annual Fieldworks Courses of R.E. Units from 1909–11 or from work done at the S.M.E.

I. ENTRENCHMENTS.

(i.). An example is given of the details of two posts in an extended position in *Fig.* 1 (see *Plates*). The working party table for one of these posts is also given. This shows the distribution of the work between the infantry and the engineers. The local reserves of the sections are not shown on *Fig.* 1.

In the case of No. 9 post the works shown are such as could have been done in 10 hours actual working time. One section field company, R.E., was assumed available in the case of both posts.

(ii.). *Noise of Work at Night.*—On a dark still night the thud of the pickaxe was heard up to about 150 yards distance. The scraping of the shovel was less audible.

(iii.). *Method of Dealing with Wet Trenches.*—Wet trenches on a particular low-lying site were dealt with by putting a layer of 6″ to 8″ of brushwood at the bottom and covering this with about 6″ of earth.

(iv.). *Loopholes.*—Loopholes in recesses of a trench should not be placed centrally but towards the right of the recess. This is necessary in order to give room for the firer's body when he is firing to the right front.

(v.). *Overhead Cover.*—*Fig.* 2 shows a method of utilizing corrugated iron sheets for the roof of overhead cover.

(vi.). *Mechanical Alarm.*—*Fig.* 3 shows a very simple and effective mechanical alarm which will act whether the wire is cut or pulled This has been devised by Capt. E. E. B. Holt Wilson, D.S.O., R.E.

II. USE OF SPARS.

(i.). With reference to *Military Engineering*, Part III., para. 79, a variation of the method there described for fastening the top of the lever to the guy is shown on *Fig.* 4. In this case the lever will not drop from the guy until the derrick is vertical.

(ii.). *Pull of Men on a Fall.*—Experiments were recently carried out at Chatham to determine :—

(*a*). The pull of varying numbers of men on the fall (horizontal) of a tackle.

(*b*). The pull exerted by a field capstan of service pattern, with varying numbers of men at work.

Digitized by Google

In both series of experiments, the point of application of the pull was allowed to move forward at an approximate rate, as it was found with a fixed point of application, abnormally high readings were obtained.

(*a*). The series consisted of varying numbers of men from 1 up to 60. It was found that the pull appeared to vary *directly with the number of men employed*, and, for men of average weight, the experiment gave a mean value of 82 lbs. per man. This can be taken in round numbers, as 80 lbs. or $\frac{3}{4}$ cwt. (according to the unit employed) per man up to 60 men.

(*b*). The series of experiments with the field capstan gave results a little less than those given in *Military Engineering*, Part III., para. 71, the average results were approximately as follows :—

1 man 12 cwt.	7 men 45 cwt.	12 men 66 cwt.
2 men 20 „	8 „ 50 „	13 „ 70 „
3 „ 25 „	9 „ 54 „	14 „ 74 „
4 „ 30 „	10 „ 58 „	15 „ 77 „
5 „ 35 „	11 „ 62 „	16 „ 80 „
6 „ 40 „		

(iii.). *Swinging Derricks.*—The pattern given in the textbook has several disadvantages. Some of these are eliminated in that described below.

Jib.—Length as required by circumstances but should be as short as is convenient. Call its length "A." It is formed by two spars lashed together at their tips, and each lashed to a stout cross-piece about 1′ or 1′ 6″ from their butts, sufficiently far apart comfortably to encircle the standing spar.

Other cross-pieces can be added, if thought necessary (*Fig.* 5).

The blocks of the lifting and the connecting tackle at the tip of the jib are lashed opposite one another with the same rope.

The jib is slung to the standing spar by a chain, made fast by a clove hitch in its centre well up on the standing spar, above a rope collar, and each end secured to an arm of the jib, just outside the butt cross-piece.

Connecting Tackle.—The connecting tackle should be secured to the head of the standing spar by a fairly long sling, to allow the jib to be easily swung round as required.

Standing Spar.—The length of the standing spar should be about $\frac{2}{3}$ "A."

The leading block of the lifting tackle should be lashed on the standing spar below the jib and the leading block of the connecting tackle, just above the jib, both on the side to which it is required to swing the jib.

If it be required to swing the jib to both sides, alternative leading blocks should be provided both sides of the standing spar.

Digitized by Google

Struts.—The standing spar is supported by two struts, each about "A" in length.

The standing spar and struts are lashed with a gyn lashing and erected in a similar manner, so that the standing spar is vertical and the struts, in plan at an angle of about 90°, placed symmetrically with regard to the edge of the wharf, etc. (*Fig.* 6).

The struts should be butted well back to a plank abutment and picketed down (*Fig.* 7).

Guys.—Three or two may be employed.

(*a*). If three, one should be in plan at right angles to the edge of the wharf, and the two inside ones should make an angle of about 20° with the edge.

(*b*). If two, they should be above the struts in plan.

In any case, the slope of the guys should be the normal 1 in 2. Each guy should be made of wire rope if possible to avoid undue stretching, which would let the standing spar lean forward and the struts come away from their abutments.

It is also desirable, particularly if cordage is used, to put a small tackle on each guy for tautening purposes.

Holdfasts are required for each guy and it is also convenient to provide one for the running end of each tackle (*Figs.* 8 and 9).

(iv.). *Stresses in Derricks, etc.*—The following table gives the greatest stress in terms of the weight to be lifted on all members of derricks, etc. These results include an allowance for converting a live load to its equivalent dead load. In the case of the swinging derrick, the stresses are calculated on the assumption that its proportions are as given in (iii.) above.

Lifting Tackle in all cases	1·6 W.
Derrick.—Spar	2·3 W.
Guy (that takes weight)...	·8 W.
Sheers.—Spar with leading block of tackle... ...	1·3 W.
Other spar	1·0 W.
Guy (that takes weight)	·9 W.
Gyn.—Spar with leading block	·9 W.
Other spars	·6 W.
Swinging Derrick.—Jib	2·8 W.
Upright spar	3·5 W.
Strut	2·5 W.
Connecting tackle	3·0 W.
Guy	2·8 W.

III. Bridging.

(i.). *Framed Trestle of Round Spars with Trenail Fastenings.*—*Figs.* 10 and 11 show a very serviceable trestle of this nature, which has been tried on service and on training. The details are sufficiently

Digitized by Google

shown by the figures. A carpenter can fit together one of these trestles in about three hours.

(ii.). *Trenails.*—A method of making trenails from green timber by means of a die plate. The die plate consisted of a $\frac{5}{8}$" iron plate screwed to an elm block. The die hole in the plate was $1\frac{1}{8}$", while the block was bored with a 2" auger. The plate was so fixed that the holes in plate and block were concentric. The block should be 6" thick and the plate should be very securely fastened, or it will soon work loose. An oak tree was felled and cut into 18" lengths. Each length was cleft with the grain into triangular pieces by means of a felling axe and a maul. Each triangular piece was roughly whittled to size with a hand axe, and then driven through the plate. The hole in the block acted as a guide and a straight trenail resulted. The diameter of the trenail was slightly greater than the diameter of the plate hole, due to the slight expansion of the green wood, after passage through the plate.

It was found that short strokes with a heavy maul were more effectual than full strokes with a light fascine mallet. The latter caused a great deal of brooming in the head of the nail.

The plate was made by a blacksmith in 25 minutes.

After cutting and trimming it was found that four men (two at the plate and two whittling) could produce 13 sound straight trenails in 30 minutes. At the same time it was found that two men whittling could not work quite fast enough to feed the men at the plate; and the rate of output would be accelerated if three men whittled. The rough whittled pieces should be 6" longer than the desired trenail to allow of the broomed ends being cut off. The die plate should be at such a height above the ground that the trenail when driven through the plate can fall clear.

(iii.). *Comparative Trials of placing Trestles in Water.*—The methods tried were :—

(*a*). From bridge head by means of ways.
(*b*). By the Belgian method (see *Fig.* 12).
(*c*). By using a swinging derrick on a raft.
(*d*). By floating to site and up-ending by ropes.

The conclusions arrived at were that (*a*) and (*d*) were possible in sluggish streams only, that (*b*) was a slow method at first but when men got used to it, it was as good as any, that (*c*) was a very good method being quick and accurate.

For rapid work in a long bridge it will be best to work from both sides, if possible, and also to put in one or two 4-legged trestles in mid-stream and work from these as well by the method (*c*).

(iv.).—*Placing Trestles by Means of a Distance Frame.*—An adaptation of this method, whereby only one footrope is required, is shown on *Fig.* 13, which explains itself.

Digitized by Google

(v.). In these days a very important question is the passage of mechanical transport over bridges. *Fig.* 14 shows an arrangement whereby the present pontoon equipment can take the service lorries and tractors. In this the pontoons are placed at half intervals, *i.e.* 7′ 6″ and the baulks break joint. Altogether 14 baulks are used, five being grouped under each wheel track. No extra equipment is required except 14 half baulks per bridge and some means of keeping the ribands in place. These are used as wheel guides a few inches outside the wheel tracks, their attachment to the roadway should *not* be rigid. The attachment shown seems to act well. The ends of the chesses should be laced down. This bridge will take vehicles of 5 tons on rear axle and 2½ on front with a wheel base of 7½′. It has been tested by a vehicle weighing 10 tons, 6½ on rear axle and 3½ on front.

It will be observed that the waterway is below textbook requirements. These are however laid down too rigidly and the bridge as made will probably stand a current of 4 miles per hour.

(vi.). *Light Cantilever Bridge.—Fig.* 15 shows a light bridge of this type, all the joints being lashed. The upright frames and the inclined frames below the roadway were braced diagonally.

(vii.). *Light Cask Bridge.*—In order to economize lashings the method shown on *Fig.* 16 was used with success with some short piers.

(viii.). *Cask Footbridge.—Manual of Field Engineering, Plate* 49. Information derived from two independent sources shows that this bridge is formed more easily if the ends of the chesses come over the casks, instead of as shown on the plate.

(ix.). In many places bamboo poles are available for bridging and other purposes. The Chinese use lengths of the outside fibre of the bamboo as lashings and figures are available as to the strength of these fastenings. They are finished off by twisting the two ends together close against the pole and jamming them between one set of returns and the pole. The following table gives the strengths :—

Nature of Test.	Breaking Strain in cwts.	
	Lashings made by	
	Sappers.	Chinese Bamboo Workers.
1. Single lashing 4 turns	4⅞—5	6
2. Double „ 4 „	Rather over 5	8¾
3. Two single lashings crossed	8¼	10½
4. Two double „ „	—	19
5. Single lashing 8 turns, 3 frapping turns	—	8½
6. Double „ „ „	—	15

The work is hard in the hands of untrained men and in the case of 2, 4, and 6 it is difficult to get the double lashings made evenly. Care must be taken not to cut the hands with the edges of the fibre.

Digitized by Google

The lashings should be well soaked before use. They will not last longer than three or four months.

(x.). *Ramp for Embarking Guns, etc.—Fig.* 17 shows a seesaw for embarking vehicles of all kinds. This has the advantage of saving time and of allowing the end of the ramp to be put well on to the raft.

(xi.). *Trussed Chesses.—Figs.* 18 and 19 show methods of forming light footbridges for infantry in single file with trussed chesses. The 30′ span bridge was made by eight men in 45 minutes, materials being at hand.

IV. DEMOLITIONS.

(i.). *High Wire Entanglement.*—The *Manual of Field Engineering*, Section 48, 2, (ii.), (*a*) gives a method of clearing a way through wire entanglement by means of an elongated charge of explosive. It has now been found that the best results by far are obtained by placing the charge on *the top* of the wire. If the explosive is well lashed to the pole, the latter can be easily thrown across the wires. The detonator should be fixed, after the charge is in position, in the end slab nearer the attacker.

(ii.). *Demolition of Arch by Charge under Crown.—Military Engineering*, Part IV., *Plate* 33, *Fig.* 3, and *Manual of Field Engineering*, *Plate* 60, *Fig.* 2, show a method of destroying an arch by placing a charge of guncotton under the crown. It should be noted that proper contact can only be obtained rapidly when it is possible to strut the charge from underneath. When this cannot be done the trussing of the board supporting the charge will take at least one or two hours and is a difficult piece of work. The method of trussing shown on the second plate mentioned will not give proper contact in any but the very narrowest bridges.

(iii.). *Demolition of Wire Cables.*—With reference to *Military Engineering*, Part IV., para. 277, it is probable that the best results will be obtained by placing the whole charge concentrated on the top of the cable.

(iv.). A case recently occurred of the failure of a No. 14 fuze in a mine when fired by the service exploder. Subsequent trial proved that the circuit had been broken, pointing to the rupture of the bridge in the fuze. An officer present had a motor-cycle on the spot, and joined the magneto to the circuit. The spark given was sufficient to bridge the gap and the mine fired.

(v.). *Demolition of Box Girder.*—A type of girder not infrequently met with is the box girder. It is possible that the best place in which to place the charge is between the webs but it is often impossible to get at the ends of the girder. In any case the charge could only be placed near an end. It is more likely hat the charge will have to be placed on the outside. An example of successful demolition with the charge so placed is given below.

Digitized by Google

The section of the girder is shown on *Fig.* 20. The charge was calculated in a manner similar to the example given on *Plate* 38, *Military Engineering*, Part IV., except that the portions of top and bottom flange between the webs were taken separately. The charge as calculated came to 20 lbs., actually 21 were used in 24 halves of $1\frac{3}{4}$-lb. slabs. Six halves were placed in each angle as shown on *Fig.* 21, clay being used between the rivet-heads to give a flat surface. The result of the explosion is shown on *Fig.* 22. By a very slight increase in the total amount of guncotton the two charges on each side can be joined. This eliminates two detonators and consequently chances of failure.

This demolition has been repeated several times with success.

V. Siege Works.

(i.). *Construction of Blindage to Parallel in the Close Attack.*—After the parallel had been sapped the blindage was added without exposing the men. Sandbag headers were thrown out in front of the trench, leaving loopholes. On these bags rails, parallel to the trench, were placed by means of sandbag forks. Stout planks were then pushed up, a few at a time, from the bottom of the trench and rested on the rails in front and the natural surface in rear. These formed the roof and on them earth was thrown up over the shoulder.

(ii.). *Sapping.*—With reference to *Military Engineering*, Part II., para. 54, the following rates of progress for deep sap were obtained in various places. In all cases the length of sap was considerable.

(i.). 112′ in 104 hours. (Hard tenacious soil).
(ii.). $1\frac{3}{4}$′ per hour.
(iii.). $1\frac{1}{2}$′ to $2\frac{1}{2}$′ per hour.
(iv.). $2\frac{1}{3}$′ per hour.

(iii.). *Air Spacing in Tamping.*—The following table gives the data of various mines in which air spacing was tried :—

Charge of Gunpowder in lbs.	L.L.R. in feet.	Solid Tamping next to Charge.	Proportion of Air Spacing to Total Tamping.	Number of Air Spaces.	Successful or not.
60	8	$\frac{5}{8}$ L.L.R.	·156	1 of 2′ 6″	Yes
40	Camouflet. Distance to surface 18′.	5′	·350	1 of 3′ 1 of 4′	No
60	about 8	$\frac{5}{8}$ L.L.R.	·207	3 of 2′	Yes
An over-charged mine.	7	$\frac{6}{7}$ L.L.R.	·095	1 of 2′	Yes
50	8	$\frac{1}{2}$ L.L.R.	·272	1 of 3′	No
50	8	L.L.R.	·277	1 of 5′	Yes
50	8	$\frac{3}{4}$ L.L.R.	·333	2 of 3′	Yes
22	6	$\frac{5}{6}$ L.L.R.	·250	1 of 3′	No
Example in	Part IV., *Mil. Eng.*	...	·294	2 of 5′	Yes

Digitized by Google

It is difficult from these results to deduce accurate rules for the proper amount and situation of air spacing, but there seems some justification for the following :—

If tamping is carefully done air spacing up to $\frac{1}{3}$ of the total amount of tamping may be introduced, provided there is solid tamping next the charge equal to $\frac{3}{4}$ L.L.R.

It still remains to determine whether it is better to have all the air spacing in one length or in several. The former would save time.

VI. ENCAMPMENTS.

(i.). *Washing Benches.*—A good type of washing bench for standing camps is shown on *Fig.* 23.

(ii.). *Huts.*—The thickness of the rafters, given in the table in *Military Engineering*, Part V., p. 25, for the roof of a hut covered with 6″ of earth, is insufficient. The figures 3″ to 4″ should be $4\frac{1}{2}$″ to 5″.

Digitized by Google

Works.—Trenches 10r :—½ co[mpa]s. 10. 11, R.E. must go round Sutton Valence
½ co[mpa]btain the services of 40 men with cutting tools
Sect[ion] at 6 a.m. on 19. 10. 11 at Sparks Hall.
(See map supplied). Sect[ion]
½ co[mpa]

1.	2.	3.	9.
Labour.		Where at	Sections.
Infantry.	R.E.		
½ A Co....	—	Along front, a[s] map, viz. :—	Trench Z.
Section A Co.	—	Behind hedge [a]k.	
Section A Co.	—	Behind fence a[t] k.	
Section B Co.	—	On right flank [of] ssion [to] d 10 [at]tion road.	Trench Y.
	—	On road at V b[y]	
	—	Field T ...	
½ B Co.	—	Along front, a[s] map, P.	auls. out pps.
Section B Co.	Group.	Farm building molished hou[se]	Trench W.
—	Group.	In front of Z	Trench V.
—	Squad.	Forsham, Broo[k]	
—	Section.	Houses, S, in [front]	Wire entanglement
Section A Co.	Squad.	Trenches Z an[d]	
Section A Co.	—	On right flank,	
		On left flank, C	
Section A Co.	—	In post ...	
Section A Co.	—	Hedges to front	Overhead Cover Trench Z. Trench Y similar
B Co. ...	—	As shown on m[ap]	
—	Squad.	Houses, S.	3 rows of bricks
40 civilians	—	Orchard north [of] House.	Continuous Loophole.

After noon, infantry cease work. [the] entanglement should be widened and lengthened
[and] flanks, communication trench[es]
Local reserve will cut gaps in the[ir] in their sub-section.

Digitized by Google

LIBRARY
OF ILLINOIS

Digitized by Google

A PONTOON BRIDGE FOR STEAM TRANSPORT.

By Capt. W. L. de M. Carey, R.E.

Since steam power may in future be expected to replace animal draft to some extent in the transport of an army in the field, it has become necessary to design a pontoon bridge capable of carrying greater and more concentrated loads. As the present equipment becomes worn out, it may be better to replace it with a heavier type more suited to these loads, but in the meantime, a design must be found to utilize the pontoon equipment, as now carried in the field, with as little alteration or addition as possible.

To construct a certain length of bridge, it will be necessary to use a great deal more material than hitherto, and consequently a longer time will be necessary. These two considerations bring in a new factor in the design of a heavy bridge, namely, that the ordinary type of bridge shall be convertible into the heavy type with as little labour and interruption of traffic as possible. It is certain that there will often be occasions when the commander of a force will wish to get his troops over a river as quickly as he can, when a bridge has to be constructed under fire, or when extra pontoon equipment has to be brought up from the rear of a column to provide enough for heavy bridge, and it will then be necessary in order to avoid delay to first construct a bridge for the fighting troops and to convert it to a heavier type of bridge afterwards. It follows that whilst one design may be best when a heavy bridge is to be built in the first place another one may be better when a "medium" bridge has to be converted.

Design.

The present heavy bridge with three pontoon sections to a bay of 15′ does not give sufficient buoyancy.

There are four ways possible in arranging the structure of a bridge with four sections to each 15′ namely :—

I. Pontoons at 7′ 6″ centres ; half the baulks arranged to break joint with the other half ; loose or pliable racking.

II. As above but with stiff racking or with all baulks secured to the saddles they rest on.

Digitized by Google

III. Pontoons at 7′ 6″ centres, baulks not breaking joint, ordinary racking.

IV. Double pontoons at 15′ centres.

The advantages of the several designs are :—

Design I. Distribution of load and consequent limiting of vertical motion.

Design II. Increased distribution of load and a minimum of vertical motion.

Design III. Reduction of stresses in baulks caused by distribution of load. Can be constructed from rafts or from medium bridge.

Design IV. Absence of stresses in baulks caused by distribution of load. Can be constructed from rafts, or medium bridge.

It now remains to investigate the various designs in order to discover which is the most economical of material. In all calculations unless otherwise stated the load assumed is a steam tractor with 2½ tons on the front axle and 5 tons on the rear, having a wheel base of 7′ 6″. Superstructure (double baulks and chesses) is taken as 1,500 lbs. per bay of 7′ 6″ and where a number of baulks has to be assumed for calculation, 14 is taken.

Modulus of rupture for baulks (kaurie pine) 9430. A factor of safety of 2 is given for conversion of moving to dead load, and a further factor of safety of 2 for dead load.

The following notation is used :—

L. Immersion in inches of a pontoon below normal level of unloaded bridge.

I. Immersion in inches of a pontoon below its floating level when free.

B. Buoyancy in lbs. due to immersion L. (500 lbs. to 1″).

P. Amount in inches a pontoon is raised above normal level of unloaded bridge by any distorting force, *i.e.* a negative L.

P′. A negative B corresponding to P.

R. Reaction in lbs.

D. Deflecting force in lbs.

Δ. Deflection in inches.

a, b, c,—... Pontoons in the bridge. These are used in conjunction with the above as :—D*a*—Deflecting force at *a* ; B*h* buoyancy of pontoon *h*.

ab, cf,—... Baulks.

To minimize work in calculating bending moments and deflection

Digitized by Google

the following table for the strength of one baulk is made up by means of the usual formulæ :—

Position of Load.	Span.	Safe Dead Load. In lbs.	Safe Live Load. In lbs.	Deflection per each 1,000 lbs. Load.	Deflection per each 500 lbs. Load.
1. Centre ...	15′	1886	943	1·68″	—
2. Centre ...	7′ 6″	3143	1571	·21″	—
3. End ...	7′ 6″ one end fixed	943	471	—	1·68
4. End ...	3′ 9″ one end fixed	1571	785	—	·21

It is often convenient in calculating deflection and bending moment to consider the points of load as points of support, and the force B as the deflecting force.

Design I.—There are two positions of the load to be considered.

Case 1.—When the axles are over pontoons (*Fig.* 1 on *Plate*) the pontoons *b*, *c*, *d* will sink evenly under the load over *c* and as the load taken by *a* ($\frac{1}{2}$ of 5600) is less than that taken by each of the former ($\frac{1}{3}\{11200+\frac{5600}{2}\}$), the baulk *ac* will rise clear of the pontoon *b*, as shown in *Fig.* 1.

To find the strain on the baulks, superstructure and deflection must be taken into account. Considering the baulks *bd* the concentrated load at *c*

$$= \overset{\text{(Tractor)}}{11200} + \frac{5600}{2} + 3000 \times \frac{3}{4} + \overset{\frac{1}{2}\,(ac+ce)}{\frac{3000}{4}} \times \overset{\text{(equivalent of } bd)}{\frac{1}{2}}$$

$$= 14000 \text{ live load} + 2625 \text{ dead load.}$$

$$3\,Ib + \Delta = \frac{\text{total load on } bd}{500} = \frac{17000}{500} = 34.$$

From the table if there are 10 baulks in *bd*,

$$\Delta = \frac{Ib}{10} \times 1{\cdot}68,$$

whence

$$Ib = 10\tfrac{3}{4}'', \quad \Delta = 1\tfrac{3}{4}''.$$

$\therefore$ $Ic = 12\frac{1}{2}''$ and *c* takes 6250 lbs. load.

The remaining load on *bd* at *c* is 8625 live load + 1750 dead.

From the table the number of baulks required is

$$\frac{8625}{943} + \frac{1750}{1886} = 10.$$

$\therefore$ 20 baulks are required throughout the bridge.

Digitized by Google

In this case, the adjacent portions of the bridge cannot relieve *bd* of its stresses, neither can there be set up in them a strain as great. They may therefore be left out of calculations for maximum stress.

Case 2.—When the axles are between pontoons. The proof of this case is long and as the maximum stress in any baulk does not exceed that in Case 1, it is not included here. The positions of pontoons will be as in *Fig.* 2. The maximum immersion (D) is $13\frac{1}{2}''$.

Design II.—If the bridge is considered as stiffly racked the strains tending to deflect the bridge from the horizontal are borne only by the ribands and the baulks they are lashed to. It is therefore better to consider all baulks as secured rigidly to the saddles over which they pass.

Consider a portion of the bridge as in *Fig.* 3 under two equal loads of 8,400 lbs. each. It is evident that there must be a point of contra-flexure between *d* and *i* and therefore there must be a force acting downwards between *g* and *i*, that is, pontoons *h* and *i*, at least, must be above their normal level.

Then

$$Ld - Le = \Delta e \text{ of } d'e \quad \ldots\ldots 1.$$

$$Le - Lf = \Delta e + \Delta f \quad \text{approximately} \ldots 2.$$

$$Lf - Lg = \Delta e + \Delta f + \Delta g \quad \text{,,} \quad \ldots 3.$$

$$Lg + Ph = \Delta e + \Delta f + \Delta g - \Delta h \quad \text{,,} \quad \ldots 4.$$

$$Pi - Ph = \Delta e + \Delta f + \Delta g - \Delta h - \Delta i \quad \text{,,} \quad \ldots 5.$$

The deflecting forces can be found by calculating the forces acting on each set of baulks as shown in *Fig.* 3. The weight of the superstructure may be neglected in determining the levels of the various pontoons, as it has an even effect on all. From the table, line 3

$$\Delta = \frac{D}{7} \times 1{\cdot}68 = {\cdot}24D = \frac{D''}{4} \text{ approx.}$$

when D is expressed in inches of immersion.

Subtracting equation 2 from 1

$$Ld - 2Le + Lf = -\Delta f = -\tfrac{1}{4}(Lf + 2Lg - 3Ph - 4Pi).$$

From equation 1

$$Ld - Le = \tfrac{1}{4}(Le + 2Lf + 3Lg - 4Ph - 5Pi).$$

Ld can be eliminated from these two equations. In turn Le, Lf, Lg, can be eliminated and an equation $Ph = \frac{43}{460} Pi$ is obtained.

Digitized by Google

By substitution, values of other unknowns in terms of Pi are :

$$Lg = 1\tfrac{29}{460}\,Pi\,;\quad Lf = 2\tfrac{3}{4}\,Pi.$$

$$Le = 5\,Pi\,;\quad Ld = 7\,Pi.$$

Consider the part of the bridge under the load (e to e'). The resultants on pontoons d and d' must be equivalent to the loads on those pontoons.

$$\therefore\quad 16800 - Ld - Ld' = 2De + 2De' - De - De' - Df - Df'.$$

Since the loads are equal $d = d'$, $e = e'$, $f = f'$.

$$\therefore\quad 8400 - Ld = De - Df \text{ whence } Pi = 1{\cdot}15''.$$

$$\therefore\quad Ph = {\cdot}1''\quad Lg = 1{\cdot}2''\quad Lf = 3{\cdot}15''\quad Le = 5{\cdot}7''\quad Ld = 8{\cdot}0''.$$

Then $De = 4750$ lbs. and the number of baulks required to take this strain is $\frac{4750}{470} = 10$.

$\therefore$ 20 baulks are required throughout the bridge. (With unequal loads this would be increased).

Design III.—With this arrangement, when the heavier load is over a pontoon on which are the ends of two sets of baulks, the immersion of this pontoon will be too great for safety and it is necessary therefore to add a device to distribute more of the load to the adjacent pontoons *after the former has sunk a certain amount below them.* The different methods of doing this will be discussed later. It is now assumed that tie-baulks (*Fig.* 4) are secured to the pontoon c, so that after c has sunk 7" they will bear on b and d.

There are four positions of the load to be considered.

Case 1.—The loads as in *Fig.* 4.

In determining the positions taken up by the pontoons, the weight of the superstructure may be neglected as having an even effect on all, and to simplify calculation deflection is neglected at first and corrected for afterwards.

Let 2T be the tension on the fastening of the tie-baulks to c. Then T is the pressure of the tie-baulks on b and d.

Consider the equilibrium of eg

$$Re = Bg \quad 2\,Bg + Bf = 0$$

as eg is a straight line $\quad 2Bf = Be + Bg.$

Whence $\quad Re = -\tfrac{1}{5}Be.$

Similarly Ra (from a bay to the left of a) $= -\tfrac{1}{5}Ba.$

Digitized by Google

Consider the baulks *ac* and *ce*.

$$2Ra + 2Ba + Bb = T \quad \ldots\ldots 1.$$

$$2Re + 2Bc + Bd = T + 5600 \quad \ldots\ldots 2.$$

As *ac* and *ce* are straight lines.

$$2Bb = Ba + Bc \quad \ldots\ldots (3).$$

$$2Bd = Bc + Be \quad \ldots\ldots (4).$$

As the tie-baulks are 7″ from *c*.

$$\tfrac{1}{500}(Bc - Bb + Bc - Bd) = 2 \times 7 \quad \ldots\ldots (5).$$

As the load is equal to the utilized buoyancy of all the pontoons

$$Ra + Ba + Bb + Bc + Bd + Be + Re = 16800 \quad \ldots\ldots (6).$$

The result of these equations in the four cases are given below.

Case 2.—When the loads are as in *Fig.* 5.

In this case the tie-baulks will not lock and they are omitted from the calculation.

Case 3.—As for Case 1, but the positions of the loads interchanged. In this case T works out at a small negative quantity showing that the tie-baulks do not quite lock.

Case 4.—When the loads are as in *Fig.* 6.

Pontoon.	Case 1.		Case 2.		Case 3.		Case 4.	
	B.	L.	B.	L.	B.	L.	B.	L.
a	−447	− 1	− 1223	$-2\frac{1}{2}$	− 1412	− 3	34	0
b	3535	7	2443	5	3053	6	3775	$7\frac{1}{2}$
c	7518	15	6108	$12\frac{1}{2}$	7518	15	7516	15
d	4501	9	4941	10	4984	10	4258	$8\frac{1}{2}$
e	1484	3	3774	$7\frac{1}{2}$	2450	5″	1000	2″
	T = 2460 lbs.				T = − 350		T = 1057	

The greatest *total* immersion of any pontoon will be 15″ + 6″ = 2 leaving a freeboard of 8″. This latter can be increased by decreasi the clearance of the tie-baulks, but in so doing the strain on them wi be increased.

Digitized by Google

The baulks in greatest stress in each case are *ce*.

Case 1.—Moment of deflecting force at *e* is

$(Be + Re)\ 7'\ 6'' = \frac{6}{5}\ 1484 \times 7'\ 6''$.

Case 2.—Moment of deflecting force at *c* is

$(Bc + Rc)\ 3'\ 9'' = \frac{6}{5}\ 6108 \times 3'\ 9''$.

Case 3.—Moment of deflecting force at *e* is

$(Be + Re)\ 7'\ 6'' = \frac{6}{5}\ 2450 \times 7'\ 6''$.

Case 4.—Moment of deflecting force at *c* is

Resultant at $c \times 3'\ 9'' = (11200 + T - Bd - Be)\ 3'\ 9'' = 7000 \times 3'\ 9''$.

From the table it is seen that Case 2 gives the greatest stress. Allowing for superstructure, the number of baulks required

$$= \frac{6}{5} \cdot \frac{6108}{785} + \frac{1}{2} \cdot \frac{1500}{3143} = 9{\cdot}5.$$

The deflection due to the stress in each case is respectively ·6″, ·3″, 1″, ·3″. In all except Case 3 the effect on the relative positions of the pontoons and stresses in the baulks is negligible. In Case 3 there is a deflection of 1″, causing *d* to take $\frac{2}{3}$ 500 lbs. more load and *c* and *e* each $\frac{500}{3}$ lbs. less and thus reducing slightly the stress in *ce*.

The number of baulks to bear the weight of one hind wheel in the centre of a span is $\frac{5600}{1571} = 3{\cdot}5$; if three baulks are placed together under each wheel track the balance of the strain may be assumed as communicated to adjacent baulks by chesses. The number of tie-baulks required will be $\frac{2460}{471} = 5{\cdot}2$ or, if they are secured over the gunwales, $\frac{3}{5} \times 5{\cdot}2 = 3{\cdot}5$. The deflection of the tie-baulks in the latter case will be $\frac{2460}{500} \times \frac{1{\cdot}68}{4} \times \frac{8}{27} = {\cdot}6''$, and they must therefore be fixed just over 6″ clear of the gunwales. In the former case the deflection will be 1·4 and they must be secured $5\frac{1}{2}''$ clear.

Design IV.—The greatest immersion (I) will be when the heavier load is over a pontoon and will then be 17″.

The strain on the outside pontoon-sections tending to force them upwards will be 4250 lbs. each. The difficulty of arranging baulks to efficiently take this strain renders this design impracticable.

The number of baulks required for the superstructure is 15.

Comparison of Designs for Load of a Tractor only.

Design I.—Requires 20 baulks but reduces the maximum total immersion to $16\frac{1}{2}''$ leaving a freeboard of $12\frac{1}{2}''$.

In practice, racking would not be very loose, and a type of bridge would result intermediate to Designs I. and II.

Digitized by Google

Design II.—(In the case of two equal loads of 8,400 lbs. each) requires 20 baulks with metal fastenings to secure them to the saddles and reduces the total immersion to 14".

Design III.—Can be constructed with 14 baulks (or ribands) *i.e.* with baulks in proportion to pontoons as now carried, but the greatest immersion is 21" leaving a freeboard of 8". By decreasing the clearance of the tie-baulks and increasing their number, this immersion may be decreased and still leave a saving in material compared with Designs I. and II. Also a medium bridge can be converted to this design of heavy bridge.

Design IV.—Is impracticable, but might be suitable for a new equipment of a heavier type.

In a following number of the *Journal*, the effect on the bridge of a tractor drawing loaded trucks will be considered, and also some practical points of construction.

Digitized by Google

*SUPPLY OF EXPLOSIVE STORES IN THE FIELD.**

By Capt. N. W. Webber, R.E.

The pamphlet *A Study of the Rôle of Engineers in the Field*, by Lieut.-Colonel Klein, translated by Colonel J. E. Edmonds, R.E., brings to light a question which is at present rather obscure, viz. :— the question of a reserve of explosives for Engineer field units.

In a British Division all the explosive stores available are carried in the first line vehicles of the field companies; there is no reserve with the Divisional Ammunition Column, and apparently the nearest point at which a fresh supply can be obtained is the Ordnance Depôt at the Advanced Base. This means that it will be no easy matter for a Field Company to quickly replenish its explosive stores.

In the French Army, a different system obtains.

In addition to the explosives carried in the wagons of the Field companies, a certain amount is carried in the infantry section of the Divisional Ammunition Columns. Behind these is the Army Corps Engineer Park with reserve explosive stores for the two divisions of the corps, and behind that again, an army park with a further reserve for the group of corps composing the army.

In the German Army a somewhat similar system to that of the French exists. An explosive wagon to cover the expenditure of explosives in the Field Companies, accompanies the Bridging Train of each corps.

There are two points to be considered in discussing the question :—

(i.). Under what circumstances will it be necessary for a Field company to replace its explosives quickly ? and,

(ii.). How are fresh explosives to be obtained ?

As regards (i.) it is not difficult to imagine circumstances.

Consider the case of a division taking up a position with a river running across the front. Only a day is available for preparation of the position. There will be a great demand for explosives; certain bridges must be demolished; others mined ready for demolition if necessary. Buildings in the defended localities which are not required for the defence, or which interfere with the field of fire, must be removed, etc. By the end of the day, the Field Companies would find their stock of explosives considerably reduced.

* It is understood that this subject is now under consideration at the W.O.

Digitized by Google

The enemy are expected to attack next day; the Field Companies will be required to accompany the counter-attack, to assist it when it reaches the supporting points which the enemy's sappers will have strengthened, in rear of their own attack. Explosives will be required, and in large quantities too, as Lieut.-Colonel Klein clearly points out on page 159 of his pamphlet. If the companies have not been able to replenish their expenditure of the previous day, they will soon find all their explosives used up.

In the case of a force retreating and destroying the communications in its rear, a still greater amount of explosives would be required, and it would be even more necessary to have a reserve in close proximity to the Field Companies with the advanced guard, who would have to prepare the different bridges, etc., for demolition.

As regards (ii.) *Field Service Regulations*, Part II., para. 52 (1), lays down that Engineer stores will be replenished by indenting on the Ordnance Depôt. But this depôt is not with the fighting troops, but probably at least two or three marches in rear, and it is unlikely that, on the eve of an action, when the ammunition supply would monopolize a large share of attention, any transport could be spared to bring up explosives.

The solution of the problem appears to be that explosives should be recognized as the Sappers' ammunition, and as such should be given a definite place in the arrangements for ammunition supply.

The French have already done this, by including a wagon for explosives in the infantry section of the Divisional Ammunition Column, and it would seem to be advisable to follow their example. The Field Companies would not then be chary of using explosives, as they may well be under the present system, as they would know that reserve supplies were within easy reach; and it would rest with the Officer Commanding Divisional Ammunition Column to ensure that supplies were forthcoming, and not with the Commanding Royal Engineer, who has plenty of other work to do.

Although this question has been considered chiefly from the point of view of Field Companies with the Infantry Divisions, it applies even more forcibly to Field Troops with the Cavalry Division, as they would still be further away from a reserve supply, unless it is carried in the Cavalry Ammunition Column.

It may be argued, that a reserve in close proximity to the fighting troops, is unnecessary for us as our units carry more explosives than French engineer units, but that is not the point. The reserve in the front line need not be large, but the machinery for rapidly replacing expended stores, is what is required.

Digitized by Google

MAP PROJECTIONS IN ACTUAL USE.

By ARTHUR R. HINKS, M.A., Chief Assistant, Cambridge Observatory.

THE subject of Map Projections has suffered as well as gained by the fact that it has interested many mathematicians. The mathematician has evolved projections that are of the highest theoretical interest and very little practical importance, while some of the comparatively few projections that are really in use are of so little mathematical interest that they receive scant treatment in textbooks, and their real value is almost ignored.

The first is especially true of the class of projections termed orthomorphic. It is so evidently desirable that a map should be the right shape, that one would naturally suppose that a projection of the orthomorphic family must have at any rate some considerable merits as a projection for actual use; yet it is hardly too much to say that the whole family might be thrown into the sea without much loss to the maker of land maps; while if this were done the hydrographer would trouble himself to rescue only one—the invaluable Mercator.

In a School of Military Engineering whose textbook in use contains an excellent though all too brief account of some thirty principal projections, it is almost superfluous to recall to your attention the elementary facts of the subject; but perhaps you will allow me to do so very briefly.

Firstly, a map projection is not necessarily, or even usually, what the mathematician calls a projection: it is not usually a perspective projection such as may be thought of very conveniently as if it were formed by casting on a plane surface the shadow of the meridians and the parallels of latitude from a point source of light. These perspective projections are interesting, and very occasionally useful for special atlas maps, but they are of no great importance, and we shall not consider them further.

The real definition of a map projection is: Any orderly method of constructing the meridians and parallels upon a flat sheet. Among the infinity of such orderly methods we must seek those that have some valuable properties in addition to mere orderliness.

These valuable properties are of several kinds.

1. Accuracy of scale along the meridians or parallels. It is impossible that both can be correct all over the map, for an ellipsoidal surface cannot be transferred to a plane without stretching it in one direction or another. But a map may be, for example, correct in scale

Digitized by Google

along all the meridians and along one or two parallels; or it may be correct in scale along all the parallels and along one or two meridians selected at pleasure. These are valuable properties, for distances measured on such a map will be more or less correct.

2. Accuracy in the representation of areas. Many projections are truly "equal area": that is to say, areas are represented correctly all over the map. But the shapes and the distances are more or less wrong. Such maps are used for statistical purposes, but for general use we may find that the equal area property has been too dearly bought.

3. Accuracy in the representation of shape. This is not at all the same thing as orthomorphism in its technical sense. Real orthomorphism being impossible, because a plane surface cannot be made to fit an ellipsoidal surface, the mathematician has been content perforce to deal with the very diluted idea of right shape representation implied in the condition that *infinitesimal* areas shall be represented in their correct shapes. How artificial this definition and convention are may be seen at a glance. Compare the shape of Greenland, as represented on Mercator's projection, which is orthomorphic in the mathematical sense, with its shape on a globe, and you will see the wisdom of veiling misrepresentations by a decent use of the Greek language.

4. Accuracy in the representation of direction or bearing, to which we may add, ease of determining the bearing. This latter is a property which usually receives scant notice in the books, yet it is by no means unimportant. It is useful to be able to trace on the map the approximate course between any two points, and this part of the problem, especially the relation between the great circle course to the straight line on the map, usually receives consideration. It is equally useful to be able to take off the map with facility the bearing on which one starts to pursue this course; but the diverse merits in this respect of the various projections have hardly received the attention that they deserve.

5. Facility in construction and drawing. These very important practical considerations are sometimes overlooked in the theoretical treatment of our subject. Yet they may very well be given the preponderating voice in a decision between two nicely balanced claims.

Now in considering the choice of a projection we must bear in mind the great difference between the needs of

(*a*) The sheets of a topographical survey;
(*b*) Atlas or wall maps of a continent or country;
and (*c*) Maps of the whole world.

The dominant factors in these three classes are altogether different, and it is not at all helpful in our consideration of the merits of the poly-

Digitized by Google

conic projection, for example, if we contemplate the rather absurd but very frequently seen construction for the whole world on this system. For the whole world it is ridiculous, but for the single sheets of a topographical survey it is almost the best. Since the case of the topographical sheet is the last to be considered in the ordinary book treatment of our subject, and is indeed in spite of its importance sometimes forgotten altogether, we will run no risks in this lecture, but will deal with it first.

In planning the construction of the sheets of a topographical map, we have to decide in the first place, shall all the sheets be made to fit together into a whole? The sheets of the Ordnance Survey will do so, in theory; the sheets of the United States 1/62,500 map will not. In practice the O.S. sheets will not do so either: not because of any theoretical defect, but because of the irregular expansion of the paper. In practice, then, it is sufficient that contiguous sheets shall fit along their margins, and it is now generally considered to be wrong to sacrifice anything to secure a possibility of fit which can never be realized.

Subject to this condition of fit along the margins, each sheet of a topographical series *may be* constructed independently. Shall we aim at orthomorphism, or at equal area representation, or at conservation of true bearing? The answer is easy: Any one of a dozen projections is almost perfect in all these respects so long as we limit our consideration to a single sheet not more than about 4 degrees square. Convenience and ease of construction will then be the dominant consideration. So little difference is there between the different projections that may be used in such a case that it is almost impossible to discover by examining a single topographical sheet on what projection it is constructed. Yet there is one case in which the difference may prove of importance: when it is desired to produce a map on a small scale by direct combination of reductions from the individual sheets on a larger scale. We have possibly an instance of this in the map of Great Britain and Ireland on the scale of 25 miles to the inch. I have often wondered why the meridians and parallels have been taken out of that map? Was it because England is on one projection and Scotland on another? The want of fit along the Border might never be noticed, but the very slight discontinuity in the meridians and parallels might look horrible. So were meridians and parallels taken out, leaving traces of their one-time presence in the curvature of the names of the seas?

The projection originally adopted for the 1-inch map of England—Cassini's—has no special merits, and it is not now employed on any new work, so we will not consider it in detail. The particular use of it in the O.S. maps has one conspicuous demerit, in that while the meridians converge, the sheets remain rectangular, so that as one

Digitized by Google

goes east or west the meridians are more and more inclined to the edges of the sheet. This is an easy source of error in the use of the sheets for such purposes as taking off bearings for night marching, especially since it is stated in many books on military topography that for practical purposes the edges of the sheets may be considered to be N. and S. We may see in such a statement some justification for Disraeli's remark that a practical man is a man who practises the errors of his forefathers.

Modern topographical sheets are most often constructed on some form of the conical or polyconic projection, and we may spend a minute in considering the theory of these. If a cone is made to touch the globe along a parallel of latitude its surface in the neighbourhood of the parallel in question very nearly coincides with the zone of the globe, and we can make a very good projection for the representation of that zone by dividing the parallel of contact as it is divided on the globe, joining these points to the vertex of the cone to make the meridians, and drawing the other parallels, N. and S. of the parallel of contact as circles struck from the same centre, the vertex of the cone, and spaced their true distances apart. This is the simple conical projection. It is perfect in the neighbourhood of the "standard parallel" of contact, and deteriorates N. and S. because while the scale along the meridians remains everywhere correct, the scale along the parallels becomes increasingly too large. It has the considerable advantage that the meridians are straight lines.

Now let us introduce a slight modification. Instead of making all the parallels concentric circles let us construct each parallel as if it were the standard parallel for a cone tangent in that latitude. Then each parallel of our graticule is a circle as before, and the centre of each circle lies on the central meridian, but each at a different point of it. Each of these parallels is then divided truly and the meridians are curves passing through the points of division of the parallels. Such a construction has no merit for a projection of a large part of the globe, and as we have seen the figure by which it is commonly illustrated in the books serves to show this very well, while concealing the real use of the polyconic projection. For a small sheet of one or two degrees each way the meridians are so nearly straight that their curvature can scarcely if at all be detected; the parallels are so nearly concentric circles that the scale along all the meridians is correct within the possibilities of drawing. And moreover, short and convenient tables can be calculated once for all, so that any sheet may be constructed without further calculation. Such tables are those published by the United States Coast and Geodetic Survey, and the tables for sheets on the scales of 1 250,000 and 1 125,000 published by the Geographical Section of the General Staff as Appendix XI. to the *Textbook of Topographical Surveying*. For sheets on these scales nothing more can be desired; the problem is solved once for all; and it does not

Digitized by Google

appear that anything is to be gained by departing from this simple uniform procedure. The Austrian General Staff map of Central Europe is constructed on Albers' conical equal area projection with two standard parallels; this requires that on most of the sheets the scale along the meridians and parallels is wrong, though indeed by small amounts. Theoretically all the sheets fit together, and this will be convenient in preparing reductions. But it is doubtful if this gain is enough to balance the loss in exactness of scale in the individual sheets.

To complete our account of the projections in use for the sheets of a topographical survey we must mention two others:—Bonne's, and the polyhedric.

Bonne's projection is the well-known modification of the simple conic. First constructing the latter with a suitable standard parallel, we then divide *all* the parallels truly, and pass curves through the sets of corresponding points to form the meridians. This is easy to construct, and it has the advantage of being equal area, but the disadvantage of having curved meridians. It has in the past been widely used both for topographical and for atlas maps: more widely perhaps than its merits warrant. In the new French 1/50,000 map they have discarded Bonne and adopted the polyconic.

The polyhedric projection is of little interest. Take on the spheroid the four points that are to be the corners of a sheet, and pass a plane through them. Let fall perpendiculars from each point of the spheroid on to this plane, and we have the projection. In theory it is inferior to the polyconic; in practice it is for a single sheet, or for an aggregate of a few sheets, indistinguishable from it. Adjacent sheets fit along the edges, but it is not possible to combine a large number of sheets into one.

I am indebted to Colonel Close for the following list of projections used in the topographical sheets of European surveys; the list was compiled in the Geographical Section of the General Staff; and Colonel Hedley has very kindly within the last few days given me one or two additions to it.

Projections Employed on Topographical Maps.

Austria-Hungary ...	1/75,000.	Polyhedric.
	1/750,000.	Old edition. Bonne.
		New edition. Albers' conical equal area.
Belgium	1/20,000 and reductions.	Bonne.
Denmark	1/20,000.	Old map. Bonne.
	1/40,000.	Jutland. A modified conical.
	All recent Staff maps simple conic with standard parallel 56° N.	

Digitized by Google

Egypt ...	...	Conical orthomorphic.
France ...	...	1/80,000
	and	1/200,000. Bonne.
		1/100,000. Polyhedric.
		1/50,000. New map. Polyconic.
Germany ...	...	1/25,000 and reductions. Polyhedric.
Italy ...	...	1/100,000. * "Polycentric or natural" (? polyhedric).
		1/500,000. Bonne.
Netherlands	...	1/25,000. Bonne.
Norway ...	...	1/100,000. * "Crescent or increasing conic" (? conic with 2 st. parallels).
Russia ...	...	1/126,000. Bonne.
		1/420,000. Conical orthomorphic.
Spain ...	...	1/50,000. Probably polyhedric.
		1/200,000. Bonne.
Sweden ...	...	1/100,000. See Norway.
Switzerland	...	1/25,000
	and	1/50,000. Bonne.
United Kingdom—		
England	...	1/2,500, 1/10,560, 1/63,360, 1/126,720, 1/253,440. Cassini.
		1/633,600. Airy's projection by Balance of Errors.
Scotland and Ireland	...	1/63,360 and smaller. Bonne.

This list is very instructive. The very general use of Bonne's projection is high testimony to the great influence of the Depôt de la Guerre, after which the projection is often called. But it is no great testimony to the originality of thought of all those who have followed in the tradition of plotting a whole country as one sheet, and then cutting it up into a topographical series. Such a procedure has an inevitable defect, which makes it objectionable to modern taste in maps: the meridians are not at right angles to the parallels, so that a sheet bounded by meridians and parallels, as all sheets should be, is skewed and ugly in appearance. This is a grave defect which should long ago have banished Bonne's and Cassini's from the list of projections in actual use; and perhaps would have done so were it not for the immense difficulty of discarding a projection when once it has been adopted. When will the Ordnance Survey be able to issue its maps bounded by meridians and parallels? Never, is the probable answer. The change would be too costly.

We must not forget to mention the new international map on the

* Official descriptions.

Digitized by Google

scale of 1/1,000,000, with sheets covering four degrees of latitude and six of longitude. In principle the projection is polyconic, but some interesting modifications are introduced.

1. The top and bottom parallels are constructed as standard, and truly divided; the meridians are straight lines joining up these points of division.

2. But the distance between the parallels is slightly modified; the parallels are brought together by a small amount, so that the length of the central meridian is a little small, and the meridians two degrees on each side of the centre are now of the true length. The correction required to do this is very slight, amounting to only 0·01 in. at the most, and the consequent gain is therefore almost too small to be measured on the sheet; but it has an elegance which will commend it to all connoisseurs of the subject.

3. It is not laid down how the meridians are to be divided, but it may be supposed that they are divided equally.

We will now consider atlas maps, in which the range of choice and the difficulties of representation are much greater.

Take first the conical projection that we have already discussed—the so-called simple conic.

One selected parallel of latitude ϕ_0 was represented by an arc of a circle, of such length that the parallel was truly to the chosen scale; the radius of the arc was equal to the length of the tangent drawn from a point on the polar axis of the earth, to touch the earth at the selected parallel, $= R \cot \phi_0$. The other parallels were concentric arcs at their true distances from the standard parallel. The complete standard parallel subtends at the vertex, the common centre, an angle $360° \times \sin \phi_0$, and the angle between any two meridians is, in the same way, the difference of longitude $\times \sin \phi_0$.

We have seen that the defect of this projection is that the scale along the parallels north and south becomes more and more too great. How can this defect be remedied?

Keeping the one parallel as standard we have at our disposal the spacing of the other parallels and the angle at the vertex, or the inclination of the meridians one to another.

If we were to decide to retain the angle at the vertex unchanged, it is evident that by bringing together the parallels we could produce an equal area projection—the criterion for equal representation of areas being that the scale along the parallel shall be inversely proportional to the scale along the meridian. Or, on the other hand, by suitably spacing out the parallels we could render the projection orthomorphic, in the sense that the scale along the parallel should be the same as the scale along the meridian at any point. These would be possible ways of transforming the simple conic into an equal area or an orthomorphic conical projection, but they are not the best ways;

Digitized by Google

and I have mentioned them only because one might unwittingly get from the books the erroneous impression that the better constructions or solutions of the problem are the only ones.

We do much better if we allow ourselves to modify the angle at the vertex as well as the spacing of the parallels.

It is shown in all the books that we have an equal area conical projection if we construct our concentric parallels by the following law :—

Radius of the parallel of co-latitude χ_0 is $2R \tan \frac{1}{2}\chi_0$.
Inclination of the meridians $(\cos^2 \frac{1}{2}\chi_0)\, d\mathrm{L}$.

Or we have an orthomorphic conical projection if

Radius of the parallel of co-latitude χ is $m\ (\tan \frac{1}{2}\chi)^n$
Where $m = \dfrac{R \sin \chi_0}{n\ (\tan \frac{1}{2}\chi_0)}$
Inclination of the meridians is $n \,.\, d\mathrm{L}$, and is at our disposal.

In both these we have preserved the length of the standard parallel, while altering the spacing of the other parallels and the angle at the vertex.

It does not appear that there can be any proof that these particular laws give absolutely the best result obtainable, but these solutions have the merit of being concise and elegant. And they are the solutions universally known as *the* simple conical equal area and *the* simple conical orthomorphic respectively.

Our next step will be to make *two* parallels standard, that is to say, represented of their true length. It is quite evident that we can do this in an infinite number of ways. To define the precise method we have one more condition at our disposal. We might, for example, make the cone pass through the two selected parallels in place upon the spheroid ; make it in fact a secant conic. But this is a poor solution, because the distance between the parallels is then the chord instead of the arc of meridian. The true secant conic is a projection without merit. What is only too often called the secant conic, even in the best circles, is not in reality a secant conic at all, as we shall see.

With our extra condition at disposal we may make the selected parallels their true distance apart ; or we may make the projection equal area ; or we may make it orthomorphic. And we have a still larger range of possibilities at our disposal when we consider that we have not yet specified *which* pair of parallels shall be made standard. To enter upon the refinements which should guide our choice in this would take more time than we have at our disposal to-night. Moreover, I am sure that you are already familiar with the most interesting

Digitized by Google

discussion of a projection for the 1/M map of Great Britain which was published by Colonel Close in an Ordnance Survey pamphlet in 1903.

I think that it is scarcely open to doubt that for a single sheet, regardless of its neighbours, the "Minimum error rectified conical projection with two standard parallels" there described, is the most perfect projection that can be employed. But it has just the slight defect of unneighbourliness; and so I suppose that for the international map, where it is of some importance that all the sheets surrounding shall fit along the edges, the Committee were right to prefer the modified polyconic that they adopted.

It is not a little curious that the remarkable merits of the former projection were not recognized long ago. Beside the maps of Norway and Sweden, which as we have seen above are apparently on this projection, we have only, as far as I can discover, the 1/M map of the British Isles now being superseded by the new sheets on the International plan, and I think some of the Indian sheets. I cannot find a single atlas sheet on this projection, which is above all suitable for atlas maps. We can but conclude that the atlas makers are more conservative than anyone would desire.

It is hardly necessary to give here the formulæ for the various conical projections with two standard parallels; they can be found in the books. Let us remark only that they are unique solutions, for we dispose of the greater part of our freedom of choice in choosing our two standard parallels.

All these conical projections have been considered to have their vertices on the polar axis of the earth: not that this is at all necessary, for it would be just as simple theoretically, though more troublesome in calculation, if we took the cone oblique. To do so, however, is almost absurd; there was no particular objection to having a sector cut out of the polar regions, whose geography is at any rate at present very incomplete; but to produce a map of South America like the one now on the screen* is to have a touching belief in the refined intelligence of the user, who must be prepared to find in the more recondite advantages of the projection some compensation for the very obvious ugliness of the abruptly curved meridians and the missing sector of the Pacific. Oblique conical projections are to be classed as freaks, and dismissed from further consideration in a lecture which professes to confine itself to projections in actual use.

Let us now consider for a moment what will happen if we make our cone flatter and flatter until it degenerates into the tangent plane at the point where the vertex has descended, and the constant of the cone becomes unity. If the point of contact is the pole, then

*Not reproduced. See Hammer: Ueber die geographisch wichtigsten Kartenprojektionen. *Plate* IV.

Digitized by Google

obviously the meridians on the cone are at their true inclinations one to another, and the parallels are complete circles. And now if the cone is oblique? In this case the generating lines of the cone are still lines of equal and true bearing, and the concentric circles are lines of equal distance from the centre; but they no longer correspond to the meridians and parallels of the sphere. These degenerate, or as Colonel Close prefers to call them, these restricted cones, make the whole class of zenithal or azimuthal projections:—zenithal because the vertex of the cone has come down from the zenith of the map centre; azimuthal, because it is the common property of all the class that they preserve the true azimuths of all points from the centre.

Or to take the opposite manner of degeneration or restriction, let the vertex of the cone, instead of coming down upon the surface of the spheroid, be removed to infinity. We thus derive the whole class of cylindrical projections, which are, it must be confessed, of comparatively little interest or use.

Without going into further details we will make a table of the projections which correspond to one another in the conical and its derived classes.

Conical.	Zenithal.	Cylindrical.
True meridians and one standard parallel	Equidistant ...	"Plate carrée."
True meridians and two standard parallels...	—	"Plate parallélo grammatique."
Equal area, 1 st. par.	Equal area ...	—
Equal area, 2 st. par.	—	Equal area.
Orthomorphic, 2 st. par.	Stereographic ...	Mercator's.

To this list we must add Bonne's projection, the simple modification of the simple conic constructed by dividing all the parallels truly, and joining up the corresponding points by curves to make the meridians. It is equal area, but the strong curvature of the meridians is in many ways objectionable. When the standard parallel is the equator it is a straight line, and the other parallels are parallel straight lines. This, the Sanson-Flamsteed projection, is very easy to draw and for certain cases that we shall consider presently is useful.

Now let us look at the way in which these various projections are used in atlases. It is not easy to produce statistics that mean very much, because one finds so often that one or two peculiar projections are used for small and unimportant maps, "just for dandy" as Miss Kingsley's West Africans would have said.

But if we confine our attention to the principal maps of the atlas we can see that the following table fairly covers the ground.

Digitized by Google

Simple conic with true meridians, or else Bonne, is in general use for single countries, such as Germany or the United States.

Conical orthomorphic is frequently used in Debes' Atlas, but not in others.

Zenithal equidistant, or zenithal equal area, is much used for continents, and so, to a smaller extent, is Bonne.

Sanson-Flamsteed is frequent in maps of Africa and of Polynesia, that is, of equatorial regions.

Now the point that strikes one in reading any of the well-known works on the subject, is that it is extraordinarily hard to discover what are the real working errors of these various projections. There is plenty of mathematical investigation of the errors, and formulæ for the maximum alteration of angles round about a point; but such formulæ are misleading in the same way that the general theory of orthomorphism is misleading, in that they deal only with infinitesimal areas; and if one asks, what is the projection for the map of Europe that gives the most correct representation of the true distance and azimuth of the line Gibraltar—Petersburg, for example, it is impossible to answer the question.

It has seemed to me to be worth while to make some calculations in order to discover what are the magnitudes of the errors that one would be liable to commit, if one were to measure distances and bearings upon atlas maps. The results are still quite incomplete, for though I have had the valued assistance of several pupils,* I have not been able to discuss the results as thoroughly as I should have wished; and it is hard to know exactly how to present our results in a systematic and intelligible shape.

Let us begin by calculating the radii of some of the parallels in various conical projections for the map of Europe. The expressions for these radii are very different in form; it will be instructive to see how much they differ numerically.

Conical Projections. Radii of Parallels for Scale $1/10^8$.

On this Scale Rad. of Earth $= 63{\cdot}66$ *mm.* $10^\circ = 11{\cdot}11$ *mm.*

Projection.	Standard Parallel.	N.	Radii of Parallels. 30°	Diff.	50°	Diff.	70°
Simple Conic ...	50°	0·766	75·6	22·2	53·4	22·2	31·2
Conic 2 St. Par. ...	65° 40°	0·787	73·1	22·2	50·9	22·2	28·7
Con. Equal Area ...	50°	0·883	67·8	21·5	46·3	22·8	23·5
Albers'	65° 40°	0·775	73·9	22·2	51·7	22·4	29·3
Con. Orthomorphic...	65° 40°	0·800	72·3	22·3	50·0	22·0	28·0

* I am especially indebted to Mr. F. M. Deighton, B.A., Trinity College, and to Mr. T. W. Glare, B.A., Sidney Sussex College, Cambridge.

Digitized by Google

Next let us consider the errors in distance and in azimuth of a line from the centre to a corner of the map.

I take the centre in 50° N., 20° E., and consider what are the errors in distance and azimuth to extreme corners up in the north of the Kara Sea, and down at the top of the Persian Gulf.

Errors of Projections. Map of Europe. Centre 50° N. 20° E.

Errors of	Corner 70° N. 65° E.			Corner 30° N. 50° E.		
	Dist. from Centre. %	Az. from Centre. °	Area. %	Dist. from Centre. %	Az. from Centre. °	Area. %
Simple Conic ...	+2	+2·6	+10	+1	+8·5	+
Con. 2 St. Par.* ...	−2	+2·0	+3	0	−1·5	+
Con. Eq. Area ...	−1	−2·0	0	0	−5·0	0
Albers'*	+1	+1·3	0	0	−1·2	0
Con. Orthomorph. ...	−1	+1·1	+6	+1	−1·5	+10
Zen. Equidist. ...	0	0·0	+4	0	0·0	+
Zen. Eq. Area ...	−1	0·0	0	−1	0·0	
Zen. Orthomorph. ...	+2	0·0	−10	+2	0·0	+
Bonne	−2	+1·2	0	−2	+0·5	

* Standard parallels. 65° and 40°.

But Europe is a comparatively small place; let us make a similar table for the map of Asia, and take again the extreme corners, up north of Alaska, and down at Port Denison on the coast of Queensland.

Errors of Projections. Map of Asia. Centre 40° N. 90° E.

Errors of	Corner 70° N. 190° E.			Corner 20° S. 150° E.		
	Dist. from Centre. %	Az. from Centre. °	Area. %	Dist. from Centre. %	Az. from Centre. °	Area. %
Simple Conic ...	+11	+9·8	+26	+5	−12·9	+
Con. 2 St. Par.* ...	+3	+12·4	+14	−3	−3·7	+
Con. Eq. Area ...	0	−0·6	0	−3	−24·1	
Albers'*	+6	+13·2	0	−1	−0·6	
Con. Orthomorph. ...	0	+10·2	+24	−3	−7·2	+
Zen. Equidist. ...	0	0·0	+18	0	0·0	+
Zen. Eq. Area ...	−4	0·0	0	−8	0·0	
Zen. Orthomorph. ...	+11	0·0	+65	−8	0·0	+
Bonne	−5	+10·0	0	−12	+6·5	

* Standard parallels. 63° N. and 2° N.

And since in both these cases the region is entirely or largely on one side of the Equator, take for a third example the map of Africa with an extreme corner somewhere up near the borders of Afghanistan

Digitized by Google

Errors of Projections. Map of Africa. Centre 0° 20° E.

	Errors of Dist. from Centre.	Corner 35° N. 75° E. Az. from. Centre.	Area.
	%	°	%
Simple Cylindrical	+ 5	+8·6	+22
Cyl. Equal Area	+ 3	+9·7	0
Zen. Equidistant	0	0·0	+22
Zen. Equal Area	− 5	0·0	0
Zen. Orthomorphic	+11	0·0	+85
Sanson-Flamsteed	− 8	+2·7	0
Carke's Perspective... ...	+ 2	0·0	+32

Now these tables require more detailed consideration than we can hope to give them in the few minutes at our disposal; but I think that we can see at once some interesting facts.

For the map of Europe the errors are really not very large, and there is little to choose between the conic with two standard parallels, Albers', the zenithal equal area, and Bonne's.

In the map of Asia the errors are naturally much larger; but again we have the same four projections standing out as the best.

In the map of Africa conical projections are clearly out of place, and the cylindrical are not good substitutes; we are left with the zenithal equal area or with Sanson-Flamsteed.

If one had to make a definite choice of the most generally useful projection for all purposes, I should be inclined to choose the zenithal equal area; with that projection one cannot go far wrong anywhere in the world; it is equally useful for Europe, Asia, or Africa. But we must not overlook the fact that the tables above refer to measures from the centre, in which the zenithal projections have naturally an advantage. The conical on the other hand, have the great point in their favour that their properties are the same right along a given parallel, owing to their straight meridians and concentric parallels, and this may more than compensate for the superiority of the zenithal round about the centre. Moreover, the standard parallels in the above tables and calculations have been selected rather roughly, without any refined examination or attempt to make the errors along the mean and the extreme parallels equal to one another. And further, it is probable that we should lay more stress on the preservation of distances and azimuths than of areas; for it is always a difficult business to measure areas with any exactness, and the necessity for so doing will disappear when Colonel Close publishes his tables of the areas of the 10′ trapeziums, which are now, I believe, in process of computation.

If then we may venture on deducing a general rule, I think it should be: You will be safe with the zenithal equidistant; but if your map does not extend to the Equator you may do better to examine the

Digitized by Google

possibilities of a conical with two standard parallels and with true meridians, or Albers', according to the importance attached to the perfect representation of areas, and to the desirability of having straight meridians.

It is doubtful if other projections are worth considering; one may easily go further and fare worse.

We come now to the most difficult part of the subject: the representation of the whole world on one sheet. We cannot hope to preserve any reasonable representation of distances and azimuths, at least directly. If honesty in the representation of areas is our object, for distribution maps, then we may select Mollweide's, especially Mollweide's in two hemispheres; or the very beautiful transverse Mollweide that appeared as the frontispiece to the first edition of the War Office catalogue of maps; and in the second edition is degraded to a mere ornament of the cover. May I venture to express the hope that such a pretty thing will be restored in the future to a worthy position.

But if we regard a map of the world as, in the first place, a guide to getting about the world, then all the usual projections are hopeless. There is not one that will give with any ease the answer to such a question as: What course will a ship take from the Panama Canal to Yokohama? or, In what direction would a flying man start from London to go straight to Sydney?

I would invite your attention to the merits of the gnomonic projection on the enveloping cube. It has been used with great effect recently in astronomy, and I venture to think that it will be found valuable also in geography.

We note first that the cube does not necessarily touch the sphere at the poles, but that its points of contact may be chosen to suit the requirements of the cartographer. In the small example before us the United States receive the most favoured treatment, at the expense of South America and of Africa. It would be interesting to make some experiments to discover just what arrangement gives the most favourable representation of the principal land surfaces of the world but I have not had time to do so in preparation for this afternoon's lecture.

The fundamental problem in the use of such a map is to draw the great circle joining any two points. We note that a great circle, that is to say a straight line, drawn on any one face of the cube, may be continued on an adjacent face in a very simple way. Let L, M, N, be the middle points of three consecutive parallel edges, and AB a great circle on one face. If BC is its continuation on the adjacent face, we find C from the consideration that C must be as much above N as B is below L. Hence we have the rule for joining two points (*Fig.*

If the points P and Q are on adjacent faces, find by trial a point on the common edge, such that the lines SP, SQ, make equal int

Digitized by Google

cepts respectively above and below the middle points of the adjacent parallel edges. This is easily done by trial, but I do not know of any direct construction that will give the point S in a simple way (*Fig. 2*).

If the points P and Q are on opposite faces the solution is still more simple. Find the point P′ opposite P, or the point Q′ opposite Q, and join P′Q or Q′P. This gives part of the required great circle, which may be continued round the cube in the way just explained.

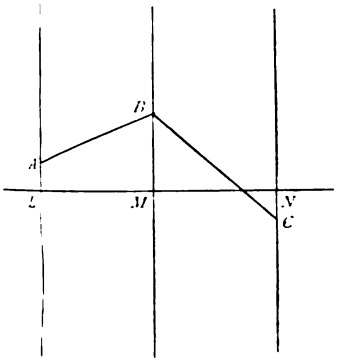


FIG. 1.

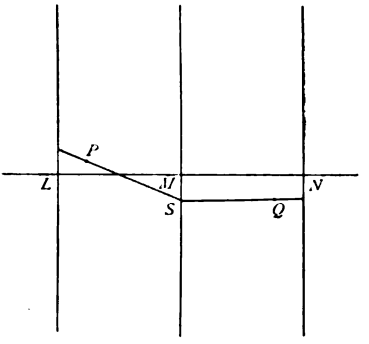


FIG. 2.

The great circle distance may be obtained very easily by means of a scale constructed as follows :—

Let C be the centre of a face of the cube, that is to say, a point of contact with the sphere, and let CM be drawn on the sphere perpendicular to a great circle through a point P. Let *c*, *m*, *p*, be the projections of these points on the cube. Then *cm* is still perpendicular to *pm*, and

$$cm = \tan \mathrm{CM}\ ; \quad pm = \tan \mathrm{PM} \sec \mathrm{CM}.$$

These are the formulæ from which the projection on the cube is computed.

If then we wish to measure the great circle distance between two points *p* and *q*, supposed for simplicity to be on the same face of the cube, we draw the perpendicular *cm* to *pq*, and determine the spherical equivalents of *pm* and *mq* separately from the above formulæ. Thus, if *cm* is $\tan\phi$ *pm* is $\tan\theta \sec\phi$; *mq* is $\tan\theta' \sec\phi$; and the great circle distance is $\theta + \theta'$.

This gives us the method of making our scale.

Divide OM as a scale of tangents, with the unit equal to half the edge of the cube. Erect perpendiculars on this scale, and divide the perpendiculars as scales of tangents multiplied by secant ($\tan^{-1}$ OM). Draw this on tracing paper, and lay it on the cube with O at the centre of the face, and OM perpendicular to *pq*. We can then read off at once the equivalents of the two lengths *pm*, *mq*. And it would

Digitized by Google

be just as easy to construct the scale so that the distances were given in statute or nautical miles, as to make it read degrees (see *Plate*).

Those who are interested in following further the geometry of this projection of the cube will find a good discussion of it in a paper by Professor Turner, *Monthly Notices of the R.A.S.*, Vol. LXX., p. 204, to which I was indebted for my first knowledge of it.

Of course areas and shapes suffer severely in those parts of the world which come near the corners of the cube; that is inevitable: but the simple geometrical construction just given enables one to draw any desired great circle; and it is not at all difficult by means of the auxiliary diagram to measure distances also. The small example that I am able to show you is traced from an old and out-of-print appendix to a report of the U.S. Coast and Geodetic Survey; its merits can be seen only when we cut up the sheet into the six separate sides of the cube, and begin to play with them.

It is now easy, with this map, to answer the questions just proposed. The great circle course from the Pacific mouth of the Panama Canal runs across the Gulf of Mexico and overland across the States nearly to Vancouver, and thence by Alaska and Kamskatchka down the coast of Asia to Japan—not across the Pacific *viâ* Honolulu as one might at first sight suppose. The consequences of this are very important. San Francisco will be a port of call on the direct sea route, and Vancouver will not be so very far off the route.

Or finally, to take the other problem: the great circle route for aeroplane from London to Sydney. You go by Copenhagen, St. Petersburg, right across Russia and Central Asia, and Southern China to Hong Kong, after which the route is more what one might expect. But I do not think that the start is quite obvious on any of the ordinary maps of the world; and I believe that this form of world-map is worthy of further study. It can be made so that it folds up into the cube and at the same time can be easily opened out flat again for storage. But its most useful form is as six separate squares which can be laid together in different ways to suit the particular part of the world under examination.

Digitized by Google

A LADY'S EXPERIENCES IN THE GREAT SIEGE OF GIBRALTAR (1779–83).

BEING THE DIARY FROM 1ST JUNE, 1779, TO 13TH JUNE, 1781, OF MRS. GREEN, THE WIFE OF LIEUT.-COLONEL GREEN, CHIEF ENGINEER OF GIBRALTAR (AFTERWARDS LIEUT.-GENERAL SIR WILLIAM GREEN, BART., CHIEF ENGINEER OF GREAT BRITAIN, 1786—1802).

(*Continued*).

Tues^{d} *7th.* Westerly wind. Cold, Damp, and Uncomfortable. In the Evening there was Some Fire Balls, Other Experiments from the South Bastion, and from the *Enterprise* Frigate. Blows hard at Bed time and all Night. 7th September, 1779.

Wed^{y} *8th.* Easterly wind. The Same Close Weather. The Enemy very Busy at Fort St Philip, bringing down from their Camp large quaintitys of Stores; some Mortars also, &c. We this Day carried up a twenty four pounder up to the North Lodgment.

Thur^{d} 9th. Easterly wind. It rained exceeding hard this forenoon. It must have given the Enemy a good weting. It cleared up in afternoon. Their Tents appear very wet.

Fry^{d} 10. Easterly wind. Our People very Busy at the New Battery above the North Bastion. It seems now to gain Credit that our Gov^{r} intends to Fire upon the Enemy Soon. The Gov^{r} is at our House this and every other Day for this last Month, but no one can tell the Result of these Meetings, as there is never any one Present, except himself and Colonel Green. I am now following the example of a good Many of the Inhabitants &c, sending some of my most Valuable Furniture and other Matters out to the South. Many of the Jews and others have obtained leave to erect small Houses, or rather Hutts, at the Southward. I have also Divided our Stores and Live Stock between this House and the Mount, as it may be very likely I and the Female part of our Family, will be Under the Necessity of going out there, in case the Enemy should Fire upon the North part of the Garrison.

Saturd 11. Easterly wind. Hear there is to be a Council of War at the Governor's this forenoon, Consisting of the three Colonels and the Admiral, as follows—The Governor, General Eliott—Lt Gov^{r} Lt Gen^{l} Boyd—Lt Gen La Motte, Hanoverians—Colonel Ross, 39th Regt—Colonel Green, Chief Engineer—Colonel Godwin, Royal Artillery—Admiral Duff—Captain Sir Thomas Birch.

Various now were people's opinions. However it was all silent. In the Evening Gen^{l} Boyd was here for two hours with the Colonel.

Digitized by Google

11th September, 1779. The Evening passed as Usual, and the Col ordered his Horses at Gun Fire the next Morning, as indeed He does almost every Morning. Every Body in the Garrison has given up all Sort of Entertaining, as Early hours at Night as well as Morning was now become Necessary, nor were the Days passed without great hurry of business. I am now coming to a very Interesting part, and will Endeavour to be as particular as I can, in order to make it Understood in a Small degree how we were all Circumstanced at this Time. Several officers were under the Necessity of keeping Journals. The Engineers all do for the Chief Engineer's Inspection, and *He* keeps a very Separate one which I believe is not intended to be shown to any one in the Garrison. My few remarks are as I said only for my Family.

Sun^{d} 12. This Morning at half past Six the Garrison began to Fire upon the Enemy. The first shot was from the New Battery call'd the *Superior*,* above the North Lodgment, 900 feet high. It was fired by Captn Loyd, Royal Artillery. We kept up a very heavy Cannonading for an hour. Most of the Garrison got upon the Hill. I never heard such a Noise in my Life. It is impossible to express the Bustle of the place. I mean amongst the Inhabitants. As to the Troops all was quiet, or as other Days. No Soldiers were allowed to go up the Mountain but those on Duty. The Gov^{r} was up as high as Williss. There was most of the officers, particularly The Artillery. There had not any Orders been given on that Head as that would have made the business too publick; Indeed I believe it was not known to Ten persons including the Council. I can safely say I had not the least Idea of it, any further than it was Universally believed We should begin in a Day or two as We all thought it was to Commence as Soon as Ever the Chief Engineer had Reported the New Batterys being ready, and He had thrown out hints of it being about the following Tuesday or Wednesday. To return now to our Morning's business. The Colonel returned to Breakfast at. From that time the firing keep up all the Day from the North part of the Rock, more or less, as our People discover'd the least appearance of any of the Enemy's Troops. In the afternoon there were Six Mortars fired, 2 of the Shells fell into Fort Barbara. We kept up till 11 at Night. An easterly wind all the Day.

It is not easy to describe the hurry that this Days business Involved every body in, as it was Supposed the Enemy would Answer our *Salutes*. I have already mentioned that many of the Shop keepers were removing their Goods &c. Great quaintitys already gone; and this Day made them truly Anxious to remove what was still left. For this business every Person had full Imployment Porters running here and there—old and young Jews frighten'd to Death almost as their *Dreads* greatly exceed all other Degrees of People. By the Night near all the North End of the Town

* Afterwards named *Green's Lodge*. See 13th inst.

Digitized by Google

totaly abandon'd, The officers were likewise trying to change Quarters, particularly such as had families. I did not move any of my family, only as I mentioned before, sent off every chief part of my most Valuable Goods. Our plate was put into a Boomb Proof, my Household Linen, Books, and Cloathes, to Store houses at the South End of the Town, and our Stock as I before said, at the Mount, leaving only real and Useful Necessaries in the Town Quarter (which is quite in the Line of Fire). During this whole Day we could easily distinguish the hurry the Enemies Camp was In, When the First Shott was Fired they were relieving the Guards at the Lines, and at the same time Large Parties were employ'd bringing down quaintitys of Stores, as Usual, in large Waggons and Carts, drawn by Horses and Mules. I saw Several myself, whose drivers had left the poor Horses &c standing, whilst They made off, We know that Several Mules and Horses were killd. The Colonel has order'd a Boombproof to be made in the lower part of our Gardens at Mount Pleasant. It was a Reservoir for Water and is about 15 Feet long, 10 Feet broad. It will be a very good and Comfortable Consideration in Case of an attack by Sea, and if that does not happen it will keep the Water always cool in case we wish to Turn into the original Intention. It appears as if it would be a very Good Place.* 12th September, 1779.

Mond[y] 13. Easterly wind. The Enemy had been heard at Work all the last Night and the Garrison had fired 6 shott in the course of the Night, and again early in the Morning. At 10 oclock I went out to the Mount to see how the things were disposed of there. A very fine day. I staid till Even[g] heard Various reports of what We had done by our yesterdays Work, The Gov[r] has given the Name of Green's Lodge to the highest Battery newly Erected which had taken the Name of Superior. It is a Work now found to be of a very Essential consequence, and was at first proposed to the Gov[r] before the least Idea of the Communication being stopt, even as March last, by Colonel Green. The Gov[r] submitted it to him, and it was begun about † weeks agoe.

Tues[d] 14. Easterly wind. The Enemy not at all advanc'd. Very few shott sent last Night. The Colonel all over the Mountain to Day. The Garrison in good Spirits, Towards the Evening the wind seem'd Westerly. One thirteen Inch Mortar fired this afternoon. Uncertain of the Effect. We are sending to the Mount more things to Day.

Wed[y] 15. Easterly wind. The Enemy much the Same, and our firing rather less. Several flying reports of our having kill'd Men as well as Horses the other Day.

* It is still used as a reservoir, but the original roof was removed about 1907 to allow the lawn tennis court to be extended.

† The figure here has been corrected and is very doubtful, but appears to be a 3 or a 5. It was actually commenced on August 20, 1779.

Digitized by Google

16th September, 1779.

Thurs^{d} 16. Easterly wind. The Garrison keeping up a smart firing all the forenoon, on account of Working parties. In the afternoon We fired three Shells from a thirteen Inch Sea Mortar, pointed from our upper heights, towards the Laboratory Tents. The two first Burst as Soon as fir'd and fell into the Sea. The third went into the Camp, within 400 yards of the Tent in Front. It has afforded Us Satisfaction in General as we now are getting the Range of our Shott &c. It is to be tried again. N.B. The Mortars are found good but not the Shells.

Fry^{d} 17. Easterly wind. Very Close and Hot. I find myself growing much indisposed. So much hurry has affected me. More Tents are pitched in the Enemy's Camp. There are 13 Battalions now come, and it is said there are to be 16 in all. There has been only one Working party seen to Day. It is Supposed they are a little Alarm'd at what passed on the 12th and yesterday, and as it is conjectured have sent off an express to Madrid. I have omitted to mention in Due place that the Streets in the Garrison were begun to be plowed up on Tuesday the 14th inst. They began in Irish Town and plowed up the Main Street to the Grand Parade. This Day They are in our Street and have come up within a 100 yards of Us.

Satur^{d} 18. Easterly wind. The Enemy the Same; We also keep up a Smart firing as of late. At Noon it began to Blow Westerly, and a Venetian Ship got In, bound for Holland. I grew much indisposed which gives me great Concern at this time.

Sun^{d} 19. Easterly wind. I had been in great pain all Night in one Foot particularly, and proposed Staying in bed all Day. However upon hearing that the above Mentioned Vessel was going to Sea this Day, I used every endeavour to write home and would not on any account mention the painful Situation I was then In. I wrote to my Sister and inform'd her that We had been very *Noisy* and Busy ever since this Day Week. We had Several Gentlemen to Dine this Day and in the afternoon the Colonel was obliged to go out at Landport to make *Observations*. He went as far as the Gardens! with only one *Orderly* Sergeant, as it was not proper to take any Number! I was uneasy till He came back. A Shell was Fired this afternoon with good success at Fort St Philip. In the Course of last week—about Friday—the Cupola of the White Convent* was taken down also the Arch and upper part of the Governor's Church.† All the Inhabitants and Shop keepers in the Main Street from Bedlam Barracks down to Waterport have left their houses. At 8 this evening a great Number of Shells and Shot were fired. It surprised most people, what could occasion so Much Firing. Captn Johnson upon the Batterys.

* Probably the Whitefriars Monastery which was at this time the Admiral's residence. The site is now occupied by Bland's Stores.

† The King's Chapel.

Digitized by Google

Mond 20th. Easterly wind. The captain of the Batterys began to Fire as soon as Day appeard and fired an amazing Number of Shells, so much that it is allowed He could not have kept up a heavier fire had the Enemy been at the Gates. This conduct is disapproved of. Major Lewis* relieved him this morning. N.B. This is the first Day that the Major has fallen In to do the Duty of Captain since He had the Brevet Rank of Major. The Enemy has made some few advances, and have taken down some Stone Centry Boxes, likewise the Roofs of some Guard Rooms. In the Evening we threw some Shells, with good Success it is said, into Fort St Philip. Hear that Poca Roca cave is fitting up in high order for the Reception of the Governor.† The Venetian did not go last Night. Find myself a little Easier to-day. Every kind of Provision now is exceedingly dear and scarce. 20th September, 1779.

Tuesd 21st. Easterly wind. A great Number of Shot and Shells fir'd this morning. Nothing to be had at the Market except one Hog which is Sold at 3 Rials‡ per pound, equal to fifteen pence Sterling. Captn Eyre upon Batterys. Very Moderate in firing all Day and Evening. The Weather exceedingly Hott now. My foot better.

Wed[y] 22. Easterly wind. At half past 12 last Night we had a Number of shot fir'd. It continued for near a quarter of an hour, and again a few more Early in Morning. Capt Grove went upon Batterys this Morning. The Enemy have made some additional alterations in their camp, and Several Rows of Tents are pitch'd towards the Eastern Shore, in a line from the first Tents. Our firing very Moderate all Day; a few Shells at 10 at Night. We have taken no Notice of this day, viz., the Coronation Day.

Thur 23. Easterly Wind, fine Day. One other Tent, a Laboratory one it seems, Under the Queen of Spain's Chair, and likewise an Additional Number to the Left Line. Capt. Loyd upon the Battery o Day. Very Moderate in firing all Day. More Tents in evening. find that most of the Regts are come to the Camp except one attalion of the Catalonians.

Fry[dy] 24. Westerly wind. Little Firing this Morning. Hear the nemy has made More advancement in their Lines, and also that Mortars are at the Lines. This piece of News is doubted by some. apt Paterson upon the Batterys to Day.

Satur[d] 25. Westerly wind. No Firing all Night. Capt Sowerby on the Batterys to Day. In the afternoon we fired 6 Shells from ueen's Lodge; five and half Inch Shells, out of a twenty four pounder.

* This officer was in command of the Artillery at the end of the siege, having succeeded Lieut.-Colonel Tovey who died on 27th November, 1781, and who had himself succeeded Colonel Godwin.

† It was never taken into use by him.

‡ Capt. Spilsbury in his diary gives the following monetary table:— 1 Dollar is 8 Reals; 1 Real 16 Quarts; 1 Pistol, 5 D. 5 R.; 1 Cob 12 Reals; 1 Doubloon 22½ D. The Dollar at 42 pence sterling makes the Real worth 5¼ pence.

Digitized by Google

25th September, 1779.

4 went into Fort Barbara, one into the Sea, the other Burst. Two Bullocks, belonging to the King's Works, are to be killed for to Morrow; which are by the Chief Engineer's orders to be Sold at a Rial and half. All the beef that has been of late were sold at 3 Rials pr lb.

Sun^d 26. Westerly wind. Very little Firing last Night. Capt. Johnson upon Batterys this Day. The Enemy preparing for Enlarging their Camp. This Day at Noon a Soldier of the 72nd, employed as a Carpenter out at Landport, went off the Works and got to one of the Hutts; was fired at from Williss with Grape Shott and also Some Shells; and Some Shott went into the very Hutt. The Man was not seen at all. It is therefore Uncertain whether this man is killed or remains there, to get off in the Night. This afternoon a Dutch Vessel was coming In. The Enemy's Row Galleys and Boats took Her when she was very near our Admiral and carried her over to Algezira. This whole Day the Spainish Admiral has had a Red Flag Hoisted upon his Main Top. They examined the Dutch Vessel and then let her go. A Top Sail Vessel appear'd from the East this Even.

Mond^y 27. Westerly wind. The Spainish Admiral has the Same Red Flag hoisted this day. This Morning a Swedish Vessel taken Supposed to be the one that was in Sight last Night. She was also Carried over to Algezira. She Saluted the Spainish Admiral with 7 guns who returned 3. Major Lewis upon Batterys.

Tues^d 28. Westerly wind. No material alteration in the Camp. The Spainish Admiral has the same Red Flagg for the third Day.

Wed 29. Westerly wind. The Enemy are getting Mortars up the Point, Fort Negro. Capt Martin upon the Batterys. The Spainish Admiral has not the Red Flagg this Day. It is conjectured it has been owing to a Court Martial held on board. Very little Firing this Morning. Mr Holloway came down at Noon from the Midshipman's lookout and reports that He has very clearly seen 4 Mortars Mounted at Fort Negro. He Saw Some of them as they were bringing from the Orange Grove, drawn by 20 Mules each Mortar. There has orders been given this day for the Steeple of the Spainish Church to come down, and the Clock and The Bells likewise. This Evening was cold and damp. Great Complaints for want of Fresh Provision.

Thur^d 30th. Westerly wind. Colonel went up to Williss. Guns Grove upon the Batterys. The Mortars are removed from Fort Negro and taken to the Lines. This is a cool Morning, and at Noon it appeared like Rain. There was some Veal in the Market which was Sold at 5 Rials, 2 Shillings of English money, pr pound. Even at Sun Set, when the Enemy fired their Evening Gun as Usual at Point Negro there was a Ball in the Cannon. It was See Many as it fell into the Sea. It is supposed to have been owing their having Neglected to take out the Ball in the Day time, as

Digitized by Google

always Used to do. We have been very Moderate in the Firing this Day. 30th September, 1779.

October 1st. Fryd. Westerly wind. This Day the Guards mounted at 8 oclock. Capt Loyd at the Batterys. We have keep up a Smartt firing this Morning. Writing a letter to my Son to go by the Venetian Ship which was to have gone upon the 20th of last month.

*Satur*d 2. Westerly wind. Colonel went up to Rock Guard. Capt Sowerby upon the Batterys. Very little firing this Morning. The Enemy are Unroofing a Guard Room at the Lines. N.B. It is to be remarked that We have been very attentive in one point, which is that of never having fired any one Shott at the officers Guard Rooms. It has in general been directed to the Working parties, &c. It rained a little this Day and Blows fresh in Evening which gives Us hopes of Boats coming over from Barbary.

Sund 3. Westerly wind. In the Night it began to Rain pretty hard attended with Thunder. At Guard Mounting it came on very hard. Capt Johnson upon the Batterys. The Govr has order'd that there should not be any 13 Inch Mortars fired to Day. At Noon it Cleared up and the Wind came to the East. Several Shott in afternoon. The Enemy have brought down a Mortar to the Artillery Park. The Venetian sailed this aftrnoon. It rained all the Evening very hard.

Mond 4th. Easterly wind. A man of the 58th Deserted last Night from Middle Hill Guard. This makes 5 that have deserted since the Investment, three Hanoverians, one of the 72nd and this of the 58th. The Enemy have lighted up Fires in their Camp to air Themselves after the Rains. Major Lewis upon the Batterys to Day. The Enemy have added 2 more Laboratory Tents in the Artillery Park, one in the Front, the other in the Rear.

Tuesd 5th. Westerly wind. Raining very fast. Captn Eyre upon Batterys to Day, Very little Firing. The man who Deserted Yesterday was found this forenoon, quite Dead and most of his Limbs Broke to pieces.

Wedy 6th. Westerly wind. Captain Martin upon Batterys to Day. The Enemy has brought down 2 More Mortars to the Artillery Park. A few shott fired to Day. In the Evening We had a Signal for a fleet.

Thurd 7. Westerly wind. Fine Morning. Col. went to the South and to New Mole. Capt Patterson upon the Batterys.

Fryd 8. Easterly wind. Capt Loyd upon Batterys. A French Privatter took a Swedish Vessel as she was coming In and carried her over to Algezira. Our Artillery People are very Busy this Day Mounting a twenty four pounder up to the Rock Guard which is an amazing height! and of course a very difficult Business. The bomb Proof at Mount Pleasant is now Completed, only wants Airing. It is a very Comfortable looking place.

*Satur*d *9th*. Westerly wind. Fine Morning. The Colonel at the

Digitized by Google

9th October, 1779. Castle before Breakfast. About 10 this Morning a firing began in the Bay, between some Spainish Row Boats and some Xebeques, and the *Childers* Sloop of War, who was going out to protect some of our Men of Wars Boats who had taken a Prize and was bringing it In. They were fired upon; a chace ensued and it obliged the Sloop to return to her Station after having been out about an hour in whic time she had got up nearly as far as the Orange Grove and had bee fired at from Fort Negro. Admiral Barcelo, &c, and all the Cam had Turn'd out Under Arms. Captain Paterson upon the Battery This forenoon a Circumstance happened in the Bay, besides what have just mentioned, that gave great displeasure to the Garrison, viz a Boat from Barbary loaded with Bullocks was going over to Algezir about the time of the Sloop being out in the Bay. It is Supposed that We might have brought Her Into the Mole with Ease, had our Frigate gone out. All this adds to the discontent of every Body, and many very Disagreable things were said on the Occasion, and some o the officers of the Navy and Army behaved in a Slighting Manner t Admiral Duff Who carried it with an Air of Indifference!

Sund^{y} 10. Easterly wind. A very fine Morning. Colonel upo the Rock. Breakfasted with Captain Sowerby who had the Battery to Day. Very moderate in the Firing all day.

Mond 11*th*. Easterly wind. A Dull Day. Major Lewis upon th Batterys. The Enemy Seem busy upon the Common about 10 yards from the Strand, between the two Guard Rooms. They ar employ'd throwing up Some kind of Work. They have about 1 Men at Work.

Tues^{d} 12. Easterly wind. At the Castle before Breakfa Captain Eyres upon Battery. Two Town Boats for Cattle sailed l night, one of which was pressed by a Spainish Vessel, which obli the Towns People to quit Her, and take to a Smaller Boat. Th took our Vessel and Carried Her over to Algezira. The other got s to Tangier. Very little firing all Day.

Wed^{y} 13. Easterly Wind. Capt Martin upon Batterys. T Colonel went up the Hill at 10 oclock to see the Gun Fired from t Rock Guard, attended by Capt Loyd who Laid the Gun. Th Fired at the Western Fort. Most of the Shott took place and grea alarmed a Party of Dragoons who at first took it to be the Blast of the Rock, till such times as they found the Shott amongst the They then made into a Ditch.

Thurs^{d} 14. Westerly wind. Captain Patterson upon Batte The Colonel at the Castle before Breakfast. Last Night a H verian Captn Belonging to La Motte's Died Suddenly. A man of 58th trying to Escape from Middle Hill was Dash'd to pieces. this time I was Taken exceedingly ill and continued so till the of the year. I shall not therefore be able to put down any D occurrence. However the most Essential I shall Endeavour to

Digitized by Google

down Here, as I was just Enabled to put a few Interesting Circumstances into my pocket Book; which makes me able to carry on a Sort of Journal; at least of what was Most Material. 14th October, 1779.

On the *27th* of this month I wrote to my Sister by a Venetian ship which did not sail (till) the 2d of Novbr. I was not able to keep up any Journal. Nor did any very Interesting or Essential change or Difference in our Situation occur. Every Article of Provision had long been too Dear and too Difficult to get. This had made it a very Uncomfortable Circumstance to every one in the place. However upon the whole the Troops keep up a very great degree of Spirits. Nor ought I to omit Saying that the Governor took every Necessary Means to take care of them and their Families, Endeavouring by every method to oblige them to Lay In as much fresh Dry Stock as it was possible for them to get; and therefore every officer help'd their men and at least to answere for them. However the poor Inhabitants began to look in a very Uncomfortable Way; the Jews in Particular.

*November 1st.**

11th. Thursday. The two first Deserters came In, of the Wolona Guards.†

Sunday 14. This morning a fine Cutter was chased into the Bay by the Spainish Men of War. She got to Windward of the Enemy and drove the Spainish Admiral &c behind the Hill. She proved to be a Folkestone Privatter called the *Buck*, Captain Fagg. He Brought Her In with the Utmost Conduct as a Sea Man and with Spirit. From this time the Enemy's Fleet was dispersed and left *US* Sole Masters of the Bay; it was therefore expected that *We* should have availed ourselves of it. However it did not turn out So! As our Men of War made no attempt to move. All this Seeming Neglect hurt Every Individual in the Garrison; and Several very Severe Papers were put up on the Different Parades Reflecting upon the Admiral's Conduct. A Windmill was now Erected up the Hill, near the Garrison Hospital, in order to Grind the Wheat that was taken from the Dutchman. Many of the Inhabitants in much want. The Chief Distress is the Want of Flour and of Firing—two very great Wants indeed.

about *the 20th*. The Enemy took Two Neutral Ships in the Face of the Garrison and very near to the English Admiral, and one of them was a Swedish Vessel Loaded for this place belonging to some Jew Merchants, who inform'd the Admiral it was the Vessel they expected as she made the proper Signals, but He did not chuse to send her any assistance! by which We had the Mortification to see her taken over to Algezira, and We Were deprived of Many Articles this Garrison stood in great need of, particularly Coals as the owners

* No entry follows this date.
† The Walloon Guards.

Digitized by Google

20th November, 1779. were certain there was a Large quaintity on board. About this time Mr Holliday, the principal Baker in this Garrison, refused to Bake, owing to the want of Wood. He had at this time 51 Sacks of Flour left. The Govr took them all away except two which He allowed him to keep for his Family. In the beginning of this Month the Small Pox first Broke out in the Garrison. It began in an Inhabitant's House, a poor Jew's. One child was nearly Recovered before it was found out, and an other taken ill. Every Method is taken to prevent the disorder spreading, as it would have been a very bad thing at this time. The Means were used as follows—an examination was made amongst the Different Regts of those Men who had not had the Small Pox, and they were directly orderd out to the Southward, and the same Number Sent In to do the Duty; the Jew's family was removed to a House in Irish Town; a Large airy place. They were ordered to be keep close and to admit of none to those who went In with them. As other children were taken ill, they also were sent to that House; by which means it avoided Spreading. There was 7 Children in all that had it, but it never took amongst the Troops. I shall observe when the Troops were brought back to their Respective Regts.

Upon the 27th of Decbr the Small Pox being all over the Troops were all properly fix'd—the children still kept in Irish Town—and no communication whatever with the rest of their Relations. It is not certain how this Disorder got into the Garrison. Some think it was brought In by some Privatters' Men who were taken out of an English Ship which run on shore near Fort Barbara, which ship was Burnt.

December 1st. In the beginning of this Month the Weather was very Mild and pleasant. I went to the Mount for a week.

10th. I wrote to my Sister, sent it by a Packet Boat to Barbar I was taken ill about the Middle of this Month and came to Tow It began to be very bad Weather; and also the Garrison had all t appearance of having a very bad Season in all Respects coming o The Troops were Well and as yet in good spirits, but the great Wa of Flour and of Firing began to oppress. The Boat which had go over upon the 10th to Barbary came back a few Days bef Christmass and brought a very few Goats and fowls which sold an amazing Price. There was some very bad Beef, old Cows, to kill'd against this Holiday time—(as it used to be call'd)—but so and so very Dear that it could not be thought of (but) by very indeed. It now Rained every Day.

Christmass. This Day was tolerably fine as to the Weather, every Body tryd to appear Easy and Contented. We had a Friends to dine with Us, and upon the whole we did the Best We co

Sund 26. Raining and Unpleasant Weather. The Enemy q just now; many of their Tents are unpitching, and it is rather at

Digitized by Google

time an *Hutment* than an Encampment of Tents. We Seem to Understand by Several More Deserters that They are in nearly as Much Want as ourselves. 26th December, 1779.

Mond[y] *27.* The Enemy this forenoon Fired 4 shott, supposed to be at our Fisher Men who had indeed gone too near the Spainish Coast. One of the shott, a twenty four pounder, went into the Head of the Princes Lines, but did no harm. It Blowed very hard all this Day and the next Night; but to let us See how Unexpectedly the Goodness of Providence is at Such times as We poor shortsighted Mortals think ourselves in the utmost Danger, behold in the course of this last 24 hours We had a Blessed supply of Wood which had been brought down to the shore near to the Ruins*, intended for the Use of the Camp. It was chiefly Brush Wood. The wind Drove directly into the Bay. The same fortunate wind Drove it towards the New Mole; and it was going round towards Europa. Our Men of War sent out their Boats. They got a Large Quaintity,—and what Ever We could stop, that was done near the Old Mole and outside Landport. It was a great Supply for this Garrison, as it is at the least calculated to amount to 500 Quintals and will be enough to Supply the poor Inhabitants and Soldiers Families for Six Weeks. The Gov[r] gave those men leave to get into the Garrison who had families. It was Truly a God Send and highly Worthy to be Remembered, and it was likewise a Loss to the Enemy. Just before Christmass Day the Bakers left off Baking. We then began to Use our own Stock of Flour. We first began by taking 10 lbs of Flour and making into three Loaves, Sending Wood to the ovens (the Bakers having none). Our Flour was exceeding White and Good; there was now remaining some of the Kings flour in the Victualling office which We the second time try'd and mix'd with some of our own; it made tolerable Bread. N.B. This was flour from the wheat Ship that was taken from on board a Dutch Man some Months agoe. Several Deserters had come In from the time the two first came, which was upon the 11th Nov[br] and they all report that the Camp was very Sickly and ill provided, and that the Enemy frequently come out from the Lines and go to the Gardens of Landport and Rob. I have as yet omitted to mention that upon the 14th of this Month a Spainish Deserter of the Wolona Guards trying to Escape to Us was fired upon from Fort St Philip, and a Party of Horse came out from their Lines to take him. He was hurt by their shott and likewise received a Wound from one of the Horse Men, was taken back into the Camp and the Next Day was hanged upon a very high Gallows Erected upon a High Hill, and left hanging all Day. By the Boat from Barbary we find all Communication between that Part and Portugal is totally

* The ruins of Carteia appear to be meant. Drinkwater says the wood was washed down from the banks of the Palmones and Guadarranque. Spilsbury says about 5 tons were collected.

Digitized by Google

27th December, 1779. Stop'd. The last Venetian was took. The Boat which went over to Barbary upon the 10th Inst return'd as I have before said a few Days before Christmass and brought a very Small Supply. I shall now proceed to mention the astonishing Price of Family Articles upon the Close of this Year, but first I am to observe that whenever any of the Oxen belonging, and employ'd by the Chief Engineer, in the King's Works, was ordered to be Kill'd for the Supply of the Troops and of the Garrison—(which was done as the Grain and Straw was drawing near an End)—this Beef tho' exceeding Fatt and Good was by the Chief Engineer's orders sold at 2 Rials per lb. All other beef tho' not fitt for eating hardly for 4 Rials. The Boat brought a few Goats which sold at 18 Dollars a piece, equal to £2: 15: 0. At other times 6 or 7 Dollars was looked upon (as) rather Dear. They are cheap in Barbary. The Fowls, very bad, sold at one Doll^{r} 4 Rials. We had not any Mutton in the Market for a long time past; till the Day before Christmass when one very bad poor sheep was Kill'd!—which was Sold by the Quarter at Eleven Dollars two Rials per Quarter, equal to Six and thirty Shillings Sterling. I can not avoid Mentioning a Circumstance which happened to our family During the Blockade; One Day I had a Leg of Pork brought home from the Market; it was very good Meat, but it absolutely cost nine Dollars equal to one pound 10 shillings! what a Sum for one Joint of Meat and at that time if I had not bought it no other kind of Fresh Meat presented itself—only think of the Poor.

The Prices of Meat & Poultry at the Close of the Year 1779.

	D.	R.	Q.		£	s.	d.
Beef per lb	0.	4.	0.	...	0.	1.	9.
Veal per lb	1.	0.	0.	...	0.	3.	6.
Pork „	0.	6.	0.	...	0.	2.	6.
Goat „	0.	6.	0.	...	0.	2.	6.
Flour „	0.	2.	0.	...	0.	0.	10½.
Pease „	0.	1.	0.	...	0.	0.	5.

The above shows the high rais'd price in English as well as Spainish. As to Poultry it was not very Easy to fix a price, as one which had to dispose of any strove to get the most for the However it was in General as follows. N.B. I had no occasion buy, having most exceeding plentyfull Fowl Yards, at a very g expense indeed, but still I had enough.

	D.	R.	Q.		£	s.	d.
Turkey, a piece ...	18.	0.	0.	...	3.	0.	0.
Geese „ ...	9.	0.	0.	...	1.	10.	0.
Fowls „ ...	2.	0.	0.	...	0.	7.	0.
Ducks „ ...	3.	0.	0.	...	0.	10.	6.
Pigeons, a pair ...	1.	4.	0.	...	0.	5.	0.

and when ever we got Fish it was beyond all Price.

(*To be continued*).

Digitized by Google

TRANSCRIPTS.

SUBMARINE CABLES FOR LONG-DISTANCE TELEPHONE CIRCUITS.

Extracts from a paper by MAJOR W. A. J. O'MEARA, C.M.G., LATE R.E., *and read before the* INSTITUTION OF ELECTRICAL ENGINEERS.—*Reproduced by the Courtesy of the* INSTITUTION.

EARLY SUBMARINE TELEPHONE CABLES.

THE first submarine cable of any length specially designed and provided for telephonic purposes by the British Post Office was that between St. Margaret's Bay and Sangatte, laid in 1891; at that time the intention was to limit the use of this cable to the provision of telephonic facilities between London and Paris. Since then, many other cables have been laid (*vide* Appendix I.), and these have all been practically of the same type. The weight of copper and gutta percha in the cores was so proportioned as to make them specially suitable for use in connection with considerable lengths of land wires. The Port Mora-Donaghadee cable, for example, connecting the English and Irish telephone systems forms a link between 400 or 500 miles of land line on each side. The data available in 1890, when the first Anglo-French cable (referred to above) was designed by Mr. H. R. Kempe, now Electrician to the British Post Office, were naturally somewhat incomplete, but the results obtained with the first telephonic circuit between London and Paris have proved eminently satisfactory from the date of its first use. This has been testified to by the demand of the public, not only for additional facilities between England and France, but also for the establishment of telephonic communication between England and Belgium. In the latter case facilities were provided in the year 1902.

I was serving as a subaltern in the 2nd Division Telegraph Battalion, Royal Engineers (now "K" Company, R.E.), in 1890, and became in this way associated with the work of establishing the first international telephone circuit affecting this country, for I was charged with the duty of making all the necessary arrangements for the selection of a suitable route for the lines from London to the coast, the preparation of the estimates and the superintendence of the construction of the works necessary on this side of the water. I can still recall the anxiety that existed 20 years ago in relation to the elements of the problems concerning which so little practical knowledge existed, and which it was felt might have such an

Digitized by Google

important influence on the success or failure of the scheme in hand. Very strict instructions were issued to ensure, not only that the wires of the aerial section should be fastened to the insulators in such manner that the centres of the four wires of a twisted group would form the corners of a true square at these points, but also that the poles themselves should, as far as possible, be the same distance apart. Great care was at the same time taken to reduce the use of gutta-percha-covered wires to a minimum, and for this purpose the usual practice of leading wires into the more important post offices on the route for facilitating the localization of faults was abandoned. The first precaution is still observed, but the same attention is not demanded to-day in respect of the uniform spacing of the poles, and the introduction of paper-insulated cables has permitted a return to the normal practice of looping the conductors into the important post offices for testing purposes.

The laying of the first cable (constructed by Messrs. Siemens Bros. & Co.) was carried out by H.M.T.S. *Monarch*, under the command of the late Mr. D. Lumsden. This operation was commenced on the French coast on March 9th, 1891, on which date the French shore end was landed, the weather being favourable and fine. The late Mr. E. Graves, then Engineer-in-Chief, Mr. (now Sir) William Preece, then Electrician, and other officials from the General Post Office, had proceeded to St. Margaret's Bay to await the arrival of the *Monarch*. Shortly after the cable ship had come within sight of the English coast, it was overtaken by a sudden and violent snowstorm; the sea became very rough, and Mr. Lumsden found it necessary to cut the cable and run for shelter. For a time doubt existed as to the safety of the *Monarch*, which had completely disappeared from our view. It was not until the 12th of March that operations were again commenced and the laying of the cable completed. Within a few days after the end of the cable had been landed at St. Margaret's Bay, good commercial speech was proved possible between London and Paris.

Descriptions of the first British International telephone cable have already been published.* The essential particulars have been extracted and are given in Appendix II.

Experimental Provision of Air-Space Submarine Cable.

From time to time, the several Administrations charged with providing international telephonic services have been called upon to extend the range of communication. The problems connected with the transmission of speech have in consequence been kept constantly before their engineers and have received close study. A slight departure from the original type of cable employed was considered in 1897, when the question of providing telephonic facilities to the Isle of Wight was first raised. It was well known some 50 years ago that the high electrostatic capacity of gutta-percha-covered conductors greatly affected the transmission of electric impulses, but it was not until 1887 that a satisfactory theory of telephony

* *Electrical Review*, Vol. 27, p. 309, 1890, and Vol. 29, p. 247, 1891.

Digitized by Google

transmission was formulated. In that year, Oliver Heaviside* gave the essential parts of the theory of telephonic transmission, pointing out the importance and beneficial effects of self-induction and stating the relation which must exist between the constants of a circuit in order that electrical waves of all frequencies may be transmitted without distortion. His investigations show great power of mathematical analysis and a wonderful insight into complex electrical phenomena. To him most certainly belongs the credit of being the earliest investigator in the field of telephony to predict the measures necessary for progress in the art of speech transmission. Unfortunately, however, it was many years before any attempt was made by engineers to apply the mathematical deductions which Oliver Heaviside had placed within their reach, to the solution of practical problems in connection with long-distance telephony.

The difficulties which manufacturers may experience in realizing the specifications of the practical engineer have always to be considered whenever a wide departure from existing types of cable is proposed. So far back as 1891 Silvanus P. Thompson obtained a patent for "Improvements in means for use in or in connection with the conveyance of varying electric impulses, applicable to electric signalling for telegraphic, telephonic, or other purposes" (Patent Specification No. 22304, of 1891). The improvements suggested were the employment of distributed inductances, leaks, etc., and this patent specification may be considered to have afforded independent testimony to Heaviside's views. Engineers, however, were not convinced as to the practicability of effecting improvements in telephonic transmission by this means, and therefore a solution to the problem was sought by devising a method for materially reducing the electrostatic capacity of submarine cables. A proposal which contemplated a solution of the problem in this manner was placed before the British Post Office and was readily accepted. The air-space type of cable designed by Messrs, Willoughby S. Smith and W. P. Granville (Patent Specification No. 8573, of 1895) was, in 1897, brought to the notice of Sir William Preece, then Engineer-in-Chief to the British Post Office. The extension of the telephone trunk service to the Isle of Wight had just been sanctioned, and it was felt that a suitable opportunity existed for the employment of the air-space type of cable for the projected service. Further, it was hoped that data of a practical kind likely to prove useful in connection with future developments would be obtained by a trial of this type of cable, and in consequence, communication between the mainland and the Isle of Wight was provided by an air-space cable laid between Stone Point and Gurnard Bay, a distance of about two knots, on June 30th, 1897.

The electrical tests carried out when the cable was laid proved it to be in every way satisfactory. Speech tests were also made and disclosed no feature in the design likely to cause difficulty in practice. It was discovered later, however, that this apparent freedom from defects was due to the fact that the cable under test was of too short a length for a complete investigation of its telephonic efficiency to be made. The

* *Electrician*, Vol. 19, p. 79, 1887; Electrical Papers, Vol. 2, p. 119.

Digitized by Google

practicability of manufacturing long lengths of this type of cable, with conductors symmetrically arranged throughout their whole length, had not in fact been proved; but, at the time, the results of the tests were considered sufficiently encouraging to justify the adoption of this type of cable in connection with problems of greater magnitude, so that when an increase in the number of telephone circuits between England and Ireland was suggested in 1898, this type of cable was adopted for the purpose.

The Gutta Percha Company has most courteously supplied a short description of the method used in the manufacture of the 4-core gutta-percha insulated air-space cable laid between Nevin, Wales, and Newcastle, Ireland (Appendix III.). When this Anglo-Irish cable was tested under practical conditions, a very serious defect was discovered, namely, that when two telephonic circuits were formed on the four wires, it was not possible to carry on conversation simultaneously without overhearing; in fact, serious inductive disturbances existed between one pair of conductors in the cable and the other pair.

Great disappointment was experienced when this fact came to light, and to clear up the situation a series of experiments was arranged in May and August, 1900, by Mr. (now Sir) John Gavey on the three cables (two telegraph and one telephone) which at that time connected Nevin, in Wales, and Newcastle, co. Wicklow (Appendix IV.). These experiments were intended to determine—

(*a*). The relative volumes of sound in each cable, the terminal conditions being maintained the same in the three cases.

(*b*). Whether overhearing existed between diagonal pairs of wires in any of the cables, and, if so, to what extent.

(*c*). Whether speech was practicable through two cables of standard telegraph type (107 lbs. copper, 150 lbs. gutta percha when joined in series—*i.e.*, over 120 knots of this type of cable.

(*d*). Whether the four wires of the telegraph cables joined in multiple would improve speech as compared with that of a metallic circuit in the same cables; that is, to ascertain what effect a decrease of resistance and a corresponding increase of capacity would have on telephonic transmission and—

(*e*). Whether the superimposing of a telegraph circuit on a telephone loop materially lessens the efficiency of the telephone circuit.

The results were as follows:—

(*a*). *No.* 1 *Telegraph Cable.*—Volume of sound sufficient for commercial purposes, but no margin for extension; articulation well defined.

No. 2 *Telegraph Cable.*—Volume slightly in excess of No. 1; articulation very well defined.

Telephone Cable.—Volume excellent on each pair of diagonal wires; conversation could be carried on with receiver some inches away from ear.

Digitized by Google

(*b*). *No.* 1 *Telegraph Cable.*—There was a very faint trace of overhearing between diagonal pairs, probably due to the "twist" having been removed at the point where the cable was led into a hut at one of the landing-places.

No. 2 *Telegraph Cable.*—There was no overhearing between diagonal pairs of wires.

Telephone Cable.—The overhearing between diagonal pairs of wires was so loud and distinct as to result in the conversation on one pair of wires being easily heard on the other pair by induction.

(*c*). Speaking was just practicable between experts.

(*d*). Speaking was less practicable than in the preceding experiment.

(*e*). The volume was reduced by about one-fourth, and the articulation somewhat blurred.

The following conclusions were definitely drawn from the foregoing experiments :—

1. Commercial telephonic communication between terminal points connected by a 60-knot length of the ordinary submarine telegraph cable of the standard type is possible, but there is no margin available under such conditions for extending the range of communication beyond that distance.

2. The air-space type of cable of a similar length—60 knots—does afford a sufficient margin for extending the range of telephonic communication very appreciably if combined with suitable aerial conductors, but the existence of overhearing between the two pairs of conductors, and the disturbances introduced by utilizing one pair of wires for telephonic purposes and the other two wires simultaneously for high-speed telegraphic purposes, precludes the employment of this type of cable for telephonic purposes wholly, or for joint telephonic and telegraphic purposes, unless the telegraph circuits are impeded and worked at a low speed.

Within the last two or three years, a further series of experiments have been carried out on the Anglo-Irish air-space cable with a view to eliminating if possible the disturbances referred to. The experiments were designed with great care and were carried out for a prolonged period, but the results showed that the proposal, which had been revived, to utilize this particular cable for the purpose for which it was originally intended, would have to be again abandoned, at least for the present. There appears to be little doubt that the cause of the failure of this type of cable is due wholly to the difficulty in manufacturing it in such a manner as to ensure that the conductors shall retain the positions they are intended to occupy, *i.e.*, so that their centres shall form at every cross-section a true square.

Proposals involving the Provision of Additional Telephone Facilities between England and France.

When the question of laying an Anglo-Belgian cable in order to establish direct telephonic communication between London and Brussels came up for consideration, it was decided, in view of the failure of the

Digitized by Google

air-space cable, to use the same type as the original Anglo-French cable. The length of cable required was about 50 knots, and as it had been proved by experiments on circuits formed by looping the conductors of the cross-channel telephone cables that good speaking was possible through 80 knots of this type, it was therefore quite safe to lay 50 knots, and it was probably a wise decision to use a proved rather than an unproved cable.

In 1908 the French and British Administrations found that the public demand for telephone facilities between the two countries had increased, and as a result of the negotiations between the Postmaster-General and the French Government it was decided to provide four additional circuits (*i.e.*, two new cables) between England and France, each country providing and laying one.

In considering the best means for providing the additional circuits it was recognized that it was not a matter in which the problem consisted merely of increasing the existing number of channels of communication, but one which afforded an opportunity, whilst providing the additional facilities required, to extend the range of intercommunication so as to embrace centres not hitherto included in the international zones owing to the great distances separating them. The consideration of the problem from this point of view naturally involved the utilization of all the information on the subject of telephone transmission which had been accumulated in the Engineering Department during the past few years, in order that the design of the cable should admit of the realization of the greatest practical increase in its efficiency at a moderate cost.

Three methods of increasing the range of telephonic transmission, so far as submarine cables are concerned, have been prominently before the Engineer-in-Chief's staff, viz. :—

(*a*). By the use of heavier copper conductors, and by an increase, at the same time, of the separation between them.

(*b*). By the provision of one or more closely arranged layers of suitable iron wire over the whole length of the copper conductors in the cable—the so-called "continuous" loading system.

(*c*). By the introduction at regular intervals of suitably arranged inductance or loading coils—the so-called "non-continuous" or "coil" loading system.

Two varieties of cable in which it was proposed to obtain increased efficiency in transmission by the employment of a larger quantity of copper per unit of length have been submitted to the Engineering Department, and, needless to say, these have been very carefully considered. In both of these designs, provision has been made for the introduction of layers of paper between the copper and the gutta percha. Some particulars regarding these cables will be found in Appendix V., and it will be seen that each of them contains only a single circuit.

According to our present experience, paper appears to be a somewhat unsuitable material to employ in the manner proposed on account

Digitized by Google

of its hygroscopic qualities which cause it to absorb moisture from the gutta percha, quite apart from the question of the probable high cost of maintenance that a cable in which paper is used may involve. However, an effort is being made to discover some effective means of overcoming the practical difficulties which have been encountered, owing to the moisture exuding from the gutta percha.

A diagram of sections of various types of telephone cables that have been adopted or proposed is given in Appendix VI.

The problem is naturally one in which commercial considerations are paramount. Even a Government Department cannot really afford to provide public utility services at a very great loss, and it has been the desire of the British Post Office so to lay out its plant, especially in connection with telephonic development, that the annual revenue shall at least be equal to the annual expenditure. The natural desire of the telephone engineer is to have ready at all times schemes for extending the range of communication, in order to anticipate the demands of the public in this direction.

The question of providing cables of higher efficiency comes under consideration only as the distances of the points between which they are required become relatively great; in such cases the magnitude of the capital cost involved in providing the cables rises in a nearly geometrical ratio if the problem is solved by the simple expedient of increasing the weight of the copper conductors, and for this reason proposals for heavier copper conductor types of cable have in recent times been in abeyance.

The two practical methods—that of "continuous" loading and of "non-continuous" loading—have been the only ones considered, therefore, in connection with the proposal to increase the number of cross-channel communications. Needless to say, the advantages and disadvantages of these two types of cable have been very thoroughly studied. All available literature bearing on the subject has been scrutinized, and such information relating to those types of cable which have already been laid by Foreign Administrations have been obtained. For convenience a schedule is given in Appendix VII. of some foreign loaded submarine telephone cables which have been provided in the past,* together with a short description of what is involved in connection with the design of the "continuously" loaded type of cable. The latter type of cable certainly appears to offer an advantage, as being mechanically simpler than the "coil" loaded cable, but our investigations have shown that the increase in efficiency which it was desired to obtain could only be realized at an incommensurate cost. Moreover, it has been found that it is not possible to predict with sufficient accuracy, by mathematical calculation, the results likely to be obtained by the "continuous" loading, owing to the difficulty in attaching correct values to the electrical constants involved. In theory, the designing of a cable of this type seems to require merely the solution of the apparently simple problem of ascertaining the increase of inductance which can be obtained by providing layers of iron wire or

* *Elektrotechnische Zeitschrift*, Vol. 29, p. 586, 1908; and also *Journal Télégraphique*, Vol. 29, p. 187, 1905.

Digitized by Google

tape of known permeability over copper conductors of known diameter, assuming that the nature of the dielectric to be employed has been determined and that the overall diameter of the finished cable shall remain a fixed dimension.

An expression for the inductance of a loop, each of whose conductors is wrapped with a continuous layer of iron, is given in Appendix VIII. Although such a method of applying the iron would give the greatest possible inductance, either for a given outer diameter of the iron covering or for a given weight, yet it cannot be adopted owing to the excessively large increase of effective resistance which will accompany the increase of inductance, for at high frequences the eddy-current loss in such an iron sheath would be impracticably large. Hence the iron covering must be electrically divided, not continuous. In the cables of Appendix VII. the iron was served in the form of one or more layers of wire; and for a loop so loaded, the inductance and increase of effective resistance due to the eddies in the iron may be calculated from the further formula of Appendix VIII.

(*To be continued*).

Digitized by Google

THE SEARCH FOR SECRECY IN RADIO-TELEGRAPHIC COMMUNICATIONS.

(From a pamphlet of the Congresso Internazionale della applicazioni electriche. No. 26).

SECRET communication by wireless telegraphy from a station A is that which enables the message to be received by stations B, C o o o o to which it is desired to send it, whereas other stations either are not affected, or at any rate receive the message in an unreadable form.

The importance of secrecy varies with the nature of the transmitting stations, thus whereas it is best for messages sent by ships, whether signals of distress or others, to be received by all other ships or land stations within range, it is on the other hand highly undesirable for messages from military or postal stations to be read by any but the station for which they are intended. Postal stations will generally be long range ones, and they are not liable to intentional interference as would undoubtedly be the case with wireless stations with an army in the field.

Several methods have been adopted to ensure the secrecy of messages, viz. (1). The tuning method:—(*a*), Electrical tuning; (*b*), mechanical tuning. (2). Application of directed waves. (3). The use of a series of wave trains. (Bull's system). (4). The use of figures or of cryptography. (5). The use of mechanical apparatus inserted in the transmitter, which automatically transcribes the telegram into secret characters from which they are re-translated by a similar apparatus in the receiver. (Hovland's system). (6). The use of high speed telegraphy.

The first method is based on the known fact, that in feebly damped circuits strong oscillations are only produced under the influence of waves of frequency equal to, or nearly equal to that for which the circuit is tuned. It can be applied in two ways. With a receiver tuned to a certain frequency it is possible to adopt either of the following methods:—(1). To send waves of the same frequency, but only during the duration of the telegraphic signals. (2). To send waves of a frequency equal to that of the receiver during the transmission of signals and waves of a slightly different frequency during the rest of the time. The disadvantage of the first method is that any station which can easily tune its receiver can in a short time get the right tune and consequently intercept the message. The second method is by far the better—the difference in tuning need in the case of continuous waves only be very small (about $\frac{1}{2}$ per cent.). The receiving station must be very sensitive. It is moreover possible to occasionally vary the tunings, on a prearranged system which further increases the difficulty of intercepting the messages. The advantage of the tuning method is that communication cannot be easily interfered with except by very powerful waves, or those of the same wave-length; in fact whilst making interference difficult it does not absolutely prevent overhearing. It is generally combined with the methods which will be

Digitized by Google

subsequently described; it does not involve the use of any special detector, but admits of the employment of detectors of the most varied descriptions. (*b*). A mechanical tuning is produced, when one or more instruments in the receiving circuit, such as relays, telephone diaphragms, etc., are syntonized with the frequency of the spark, so that they become especially sensitive to impulses which possess its frequency. This method is of no particular use for the insurance of secrecy, except inasmuch as it increases the sensitiveness of the receiver and thus admits of the use of less energy in the transmitter, which makes interference on the part of strange stations more difficult.

(2). By employing directed waves, it is possible to restrict geometrically the area over which the interception of waves is possible, but stations on a direct line between those in communication cannot be prevented from reading messages. The efficiency of this method will increase when it is possible to direct waves better than at present; the fine results already achieved by Bellini-Tosi and others make it likely that this will take place.

(3). This method consists in using a set of definite series of wave-groups—a series is necessary to discharge the receiver—each series is composed of several wave-groups, emitted at varying intervals of time. The disadvantage of this ingenious system is the time it takes, for a complete series is required each time to discharge the receiver and thus the speed of sending is low. It is moreover comparatively easy for a third station to discover the nature of the series and thus intercept the message.

(4). Cryptography being by no means a system restricted to wireless telegraphy it is not necessary to describe it here in detail. Its disadvantage from the wireless point of view, is that any stray waves easily increase the difficulty of receiving, and thus special precautions must be adopted to ensure the correct receipt of the message.

(5). To Captain Hovland, Norwegian Navy, is due an ingenious system which consists in the insertion of apparatus in both transmitter and receiver, which automatically cipher and decipher messages. This is open to the following disadvantages:—(i.). The two special apparatus must be properly set. (ii.). The speed of transmission is small. (iii.). Special coherers or detectors, easily influenced by stray waves, are required.

(6). High speed telegraphy tends to make a message hard to intercept as there is but little time in which a strange station can get into tune with the two stations at work. The speeds hitherto recorded with the Poulsen system are 300 words per minute for a distance of 300 kilometres and with an initial energy of 2·3 kilowatts and 170 words per minute for a distance of 1,500 kilometres (partly over water) with a primary energy of 32 kilowatts. In the first case both masts were 65 metres high, in the second the transmitting mast was 100 metres and the receiving 65 metres. A very sensitive suspended coil galvo. was used at the receiving end.

The author concludes by stating that to ensure secrecy the best methods are; for a definite wave-length:—(1). Use of cryptography. (2). Use of the Hovland system for short distances. (3). If the stations are situated far away from one another and much trouble is expected high speed telegraphy, with or without ciphers, should be employed.

A. H. SCOTT.

Digitized by Google

THE TRANSYRIAN RAILWAY.

(From the *Revue Militaire des Armées Étrangères*, October, 1911).

ENGLAND is at present connected to India by means of two telegraph lines:—

(1). *Viâ* Constantinople, Scutari, Siwas, Diarbekir, Bagdhad and Bassorah, after which point the line is continued by the cable of the Persian Gulf Co.

(2). *Viâ* Berlin, Warsaw, Odessa, Kertch, Tiflis, Djulfa, Tavriz, Kazvin, Teheran, Ispahan, and Karachi, at which point the line joins the Indian network.

This second line is maintained and worked in Persia by an English company. Both lines follow the caravan tracks which have been in use for centuries. One of these lines, that *viâ* Bagdhad is about to be, so to speak, supported by a railway; this gives it advantages over the Persian and not improbably will result in a loss of trade for the second line. What more natural then than the construction of another railway line to support the line thus weakened.

For many years the entire export and import trade of Persia has been almost entirely in the hands of Russian or English houses, and the treaty of the 31st August, 1907, fixed the spheres of influence of these two countries. Thus Great Britain promised not to endeavour to get for her own subjects, or those of any other nation, contracts of any description or commercial advantages north of a line going from:—Kars-i-Shirim, Ispahan, Yezd, and Khakh to the junction of the Persian, Russian and Afghan frontiers, and moreover undertook not to oppose any concessions asked for or obtained by the Russian Government in the region north of the above line.

Russia makes similar promises for the country south of a line from the Afghan frontier to Gazik, Kerman and Bender-Abbas.

Finally both Russia and Great Britain agree not to oppose without previous discussion the granting of privileges to subjects of one or the other power in the district between these two lines.

The only really efficient military body at the disposal of the Shah is the Cossack brigade (eight squadrons, a battalion and two batteries) which force in view of its small numbers is incapable of keeping order in the interior of the country. For this reason Russia garrisoned the chief towns in her sphere of influence with Russian troops. The Persian Government however has begun to concern itself with the security of the regions and has asked for the repeal of the Russian garrisons. Swedish officers have been asked for to reorganize the Persian gendarmerie.

In the British sphere of influence, brigandage was in full swing in 1910, and the Foreign Office proposed the creation of a police force of

Digitized by Google

Persian soldiers and British officers on the same lines as the Cossack brigade, but measures were taken by the Persian Government and thus this scheme fell through.

There have been since 1907 repeated disputes between Persia and Turkey as to the possession of a strip of territory 30 k.m. broad and 250 k.m. long on the common frontier of these two States.

Finally Germany is seeking by means of the Bagdhad railway to open a market for its produce in Persia, and has already got one bank in the capital, Teheran.

Russia has declared herself prepared to allow the construction of the Bagdhad railway and agrees to construct a line from Teheran to Hamekin so as to join the Bagdhad line at the latter point; and in return Germany promises not to traffic north of the line Kasr-i-Shirim, Ispahan, Yezd and Khakh, and the Afghan frontier, *i.e.* the line of demarcation of the British sphere of influence. Thus the situation at present is that Russia's interests in Northern Persia remain untouched, so do Great Britain's in the south-east, and Germany awaits the opening of the Hamekin line in the west.

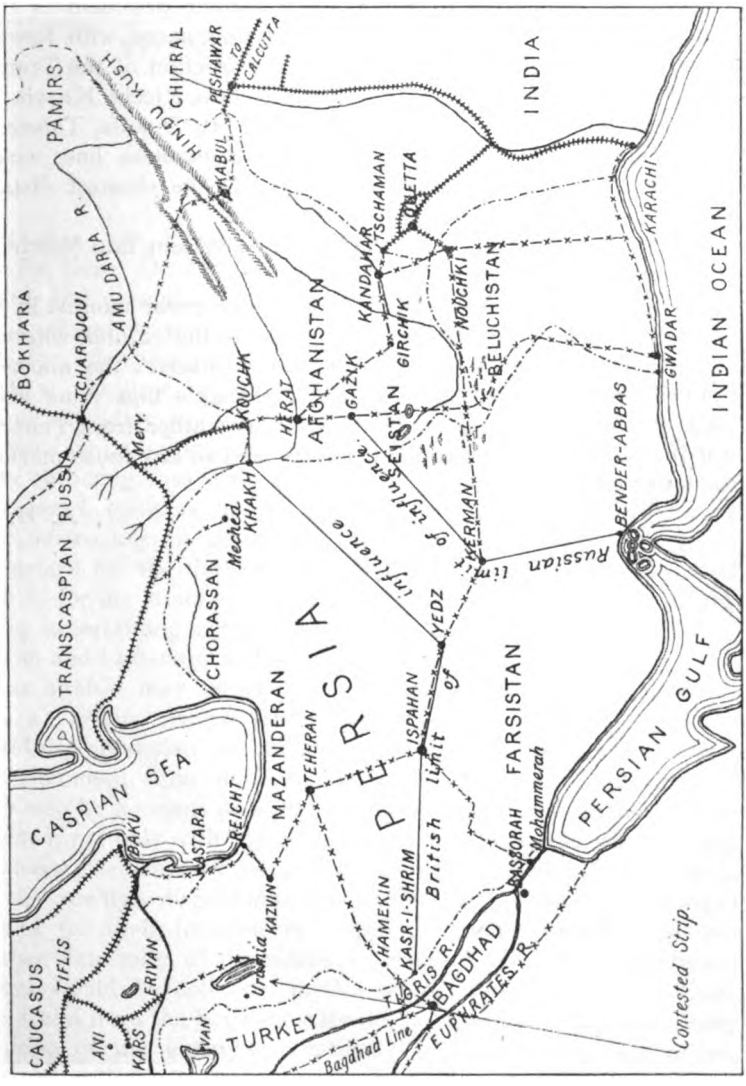
When the Persian capital is joined by rail to the Bagdhad line, the situation will alter, for then Teheran will be about equally near to the German railhead and to the Russian frontier, and German and Russian commercial interests will oppose each other. It is in fact not improbable that in certain respects the Germans will have advantages over their rivals; hence the necessity of opening up by rail some other part of the country, so as to provide a fresh market for Russian goods, and hence again the origin of the Transyrian.

The Russian idea is to combine this advance of her railway system with a through line to India, thereby getting the trade from England to India which at present seems likely to be absorbed by the Bagdhad line.

Between the Russian and British possessions in Central Asia there lies Afghanistan, a country of about the same size as France, which separates these possessions by a strip 550 to 600 k.m. wide in the south and 25 to 30 k.m. wide in the north. The country in the north is of so hilly a nature as to render the idea of crossing it by a line of rail well-nigh impossible. The conquest of this country is fraught with such difficulties as to make it a very hazardous enterprise, and more is to be gained by letting it gradually civilize itself under the influence of its own Amir. The idea of a Transyrian railway has led both countries to study Afghanistan during the last 20 years, studies which have been misinterpreted as sources of dispute, and which far from aiding the construction of the line only impeded it. It is really only since 1907, that having come to a definite understanding England and Russia are able to study together this important question which has numerous partisans in both lands. Various routes have been proposed for the line:—

(1). Of late years in England it has been suggested that the Indian railway system should be prolonged to Gwadar on the Persian Gulf, and that from there the line should go to Herat, *viâ* the Seistan, and along the Beluchi-Afghan frontier, to end at Kouchk, the present terminus of the Russian lines. The advantage of this line from the military point of view

Digitized by Google



-x-x-x- Various lines proposed to open up new districts to trade
Existing railway lines.
Frontiers.
Limits of spheres of influence.

Digitized by Google

is that it can be protected by the fleet for a distance of 400 k.m., all along the Persian Gulf.

(2). After 1907 it was suggested to start the line not from Karachi, but from Nouchki and then let it follow more or less the same route through the Seistan to Kouchk.

(3). In autumn, 1910, M. Khomiakov, former president of the Duma, and president of the Russian bank of commerce with foreign lands opened negociations in London for the construction of the Transyrian by one of the following routes :—(1). Baku, Astara, Riecht, Kazvin, Teheran, and then through the Seistan to Nouchki, (2), Djoulfa, Tabriz, Kazvin, Teheran and the same route as before. Both these lines would place Teheran 8,400 or less kilometres from Calais, the shortest distance from Calais by the Bagdhad line will be 8,660 k.m.

In Russia the extension of the Caucasus system into Northern Persia is urgently asked for.

On the whole neither country has any very great interest in constructing a line uniting the provinces of Persia to the capital, whereas on the other hand both lands wish to keep to themselves the markets of the countries round Persia, hence it seems probable that some line will be built on the route suggested in (1) or (2) (rather from Teheran southward) as a rival to the Bagdhad railway, and so tap those markets which the latter cannot touch.

A. H. SCOTT.

Digitized by Google

NOTICE OF MAGAZINE.

RIVISTA DI ARTIGLIERIA E GENIO.

September, 1911.

AERONAUTICS; ITS PRESENT CONDITION IN RELATION TO MILITARY SCIENCE.—By Capt. Ottolenghi, General Staff.—The author examines with lucidity and carefulness the practical military application of aeronautics and asks what are the practical limits? and the means of adopting an airship for offensive purposes:—(*a*), By bombarding the masses of the enemy at the time of assembly, and by dropping mines on the loading and unloading stations at the moment of confusion; (*b*), during the operations by damaging the advanced magazines and depôts of the enemy, by throwing into disorder the organizations of his retirement, troops in camp, columns on the march, while crossing a bridge, or defiles, or destroying an obstacle which delays their advance? (*c*), in fortress warfare for the defenders to ruin their adversaries' parks, and even more so for the attackers to bombard from a height the keep of the place, or by ascertaining at the right moment the opposed resistance of the garrison, and hastening the assaulting operations.

Again, an airship may be effectively employed for scouting and exploring:—(*a*), During the assembly of the troops by gaining information which could not otherwise be collected during the time that the normal means of communication between the belligerents were interrupted; (*b*), it may also be a means of exercising control over information otherwise collected, not only with regard to the army but to the whole of the enemy's country which may be preparing for the strife; it may be to ascertain the enemy's dispositions for assembling his troops in principal centres, and for their location in larger or smaller numbers, at one or the other extremity of the probable front of his initial alignment; what forces would be collected in the second line; so that the Commander-in-Chief from the beginning would be able to form a sufficiently concrete idea of the enemy's intentions; (*c*), during the operations, the aeronauts will hover and observe the exact front of the enemy's position, the initial movements of his great units, his completed works, the positions occupied by his reserves; in retreat the directions taken by the columns *en route*, their strength, and the places chosen for their halts and reorganization.

The aeronauts will more especially be able to furnish valuable information on the posts occupied by the troops who had concealed themselves in folds of the ground with the object of threatening the flanks and rear,

Digitized by Google

also regarding the position of the enemy's batteries, and the effect of their fire. In mountain warfare they will render useful service by observing the action of the enemy in the valleys, and preventing surprises; and in siege warfare they will be able to discover the ideas whether of attackers or defenders, and the relative places of attack or defence, the positions selected for the batteries, the batteries under construction, the system of commands, etc.

As a means of communication they will be infinitely more rapid than any other means that could be employed. Being independent of topographical conditions and the network of roads, the aeronauts will be able to assist in the field of strategy by co-ordinating the action of the larger units, between themselves, and with the cavalry pushed forwards in advance, as well as in the field of tactics. The immediate consequence of this new state of things is the necessity of concealment.

The action of the infantry will in the future have the characteristic of great mobility; it will have to be prepared to be ready at all costs to overcome the critical period which may now be of very serious importance, and which would become unbearable, if the soldier were not able to find any period of rest under cover of the ground or temporary entrenchments, owing to the effect of the airships.

Freed in a measure from some of the duties which absorb a great part of its activity,—scouting, etc,—the cavalry will probably return to its essential function as a combating arm, and will always assume its proper character *as an element of force rapidly placed in position.*

The artillery arm would seem to have its conditions improved owing to the possibility of discovering the concealed targets which it may have in front, and by having its fire controlled and corrected without as at present having to await the advance of the infantry. The artillery also will derive much advantage from the great distances of its ranges, without change of position which is always dangerous and is to be avoided as much as possible.

It may be said of the engineers that it is certainly destined to re-solve some of the important problems connected with military aviation and to place at the disposal of the aeronauts the latest methods of communication derived from scientific studies; especially those connected with telegraphy and wireless telegraphy.

It will probably be characteristic of the battle of the future, that the commander by the aid of the airships will have clear information of what is happening on the field; the action will be more intense and more rapid; the fronts of the alignments will be less extended than those of the last wars.

In the last and preceding wars of the latter half of the XIXth century, the battles consisted of a certain number of distinct episodes, each of which with its own character devolved from itself was quite independent of what was happening around.

In battles so conducted, the commander although he may have had at his disposal rapid means of communication and transmission of orders, was seldom able to see with his own eyes; others saw for him and hastened to report their impressions and notions. These reports

Digitized by Google

were collated and the commander with their help was obliged to form a picture that was often not in accordance with the actual facts.

Matters will certainly be changed after aeronautical science is employed as a subsidiary to military operations. The commander by means of the information given by the airship will be able to form an exact idea of the situation.

The battles of the future will be characterized by greater rapidity in the evolution of manœuvres. And the reason is obvious. That state of nervous tension caused by the continuous preoccupation of an unknown danger will be increased by a new peril threatening from above. And since the trenches and folds of the ground cannot prevent this new danger, and concealment may be a useless precaution, a feverish movement of action and of overcoming the crisis may be engendered among the troops with a view to obviating the impending danger. Hence the necessary consequence will be the rapid evolution of manœuvres.

And another characteristic of future battles perhaps will be a smaller extension of front.

Considering all these new characteristics of the battles of the future it perhaps may not be too premature to foresee a return to the Napoleonic conduct of operations, when battles were conducted in three distinc phases,—the *preparation*, the *development*, and the *crisis* and these were determined by the will of the Emperor.

So we may be induced to ask if the day may not be very far off which was prophesied in the enlightened mind of Von Goltz* in which in the face of large masses wanting in valour like the armies of Xerxes and Darius a new Alexander may arise at the head of a reduced body of soldiers, perfectly armed and exercised, solidly constituted, who would easily overcome troops innumerable but enervated and inoffensive.

Offensive and Defensive.—Authors of all times have pronounced in favour of one or the other methods of combat, Clausewitz decisively in favour of the defensive, while Blume considered the offensive as the most efficacious. No one can be surprised that the question again arises after the conquest of the air, the greatest victory over nature of any time, but we can reliably affirm that the defensive will derive greater profit from the new science than the offensive.

Instruction of Officers.—Breadth of view has always been required from officers, with a ready and safe judgment and ability to discern the truth from the false. Above all they should in all cases enquire—What is to be done in analogous circumstances? How to solve this or that tactical problem? How to exercise the command of this or that detachment?

It seems to us that in such considerations, with the new science of aerial navigation there should be created a new special instruction for officers, especially for those called upon to direct the operations of war. The picture taken from above that will be presented to the eyes of these officers will not be very different (except in its proportions) to that represented on a topographical map on a large scale, and should represent

* Barone Colmar von der Goltz—La nazione armata. Prefazione.

Digitized by Google

with proper markings, the troops on both sides. This shows the importance of instruction for officers in the study of these pictures and completing their professional culture by applying such study to the direction of manœuvres by means of the map.

E. T. THACKERAY.

BOOKS RECEIVED.

HANDBOOK OF THE SWISS ARMY. Prepared by the General Staff. H.M. Stationery Office. 1911. (*For Official use only*).

SCHEME AND ORDERS FOR THE MILITARY ARRANGEMENTS AT DELHI IN CONNECTION WITH THE CORONATION DURBAR. Superintendent Government Printing, Calcutta. 1911.

THE HIGHWAY OF THE AIR AND THE MILITARY ENGINEER. A Lecture by Lieut. Geo. A. Taylor, Australian Intelligence Corps, at the United Service Institution of New South Wales. July, 1911.

BUILDERS' QUANTITIES. By Horace M. Lewis. 1s. 6d. net, 1s. 9d. post free. E. & F. Spon, Ltd., 57, Haymarket, London.

THE RADIO-TELEGRAPHIST'S GUIDE AND LOG-BOOK. A Manual of Wireless Telegraphy for the use of Operators. With 90 illustrations. By W. H. Marchant. Price 4s. 6d. net. Whittaker & Co., 2, White Hart Street, Paternoster Square, E.C. 1912.

Digitized by Google

Fig. 1.

DETAIL OF WORK DONE AT Nos 7 AND 9 POSTS.

Digitized by Google

Digitized by Google

SOME NOTES ON FIELDWORKS.

Fig: 2.

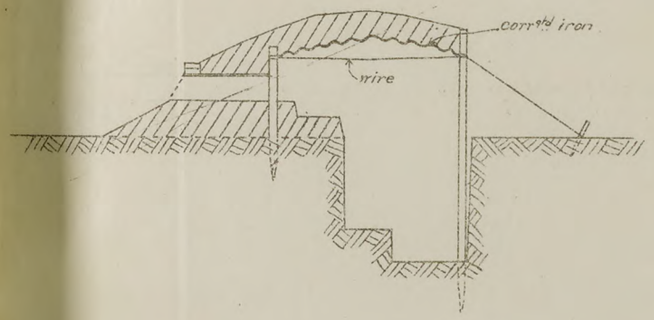


Fig 3.

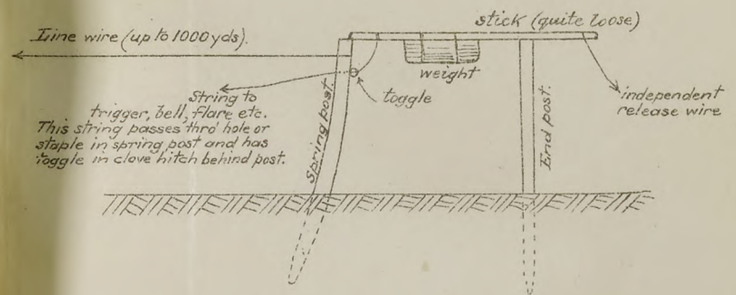

Line wire (up to 1000 yds).
stick (quite loose)
weight
toggle
String to trigger, bell, flare etc. This string passes thro' hole or staple in spring post and has toggle in clove hitch behind post.
Spring post
End post
independent release wire

Fig: 4.

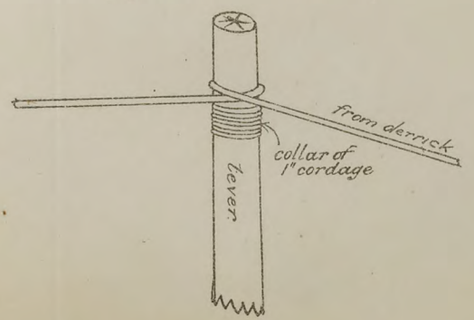


Fig: 5

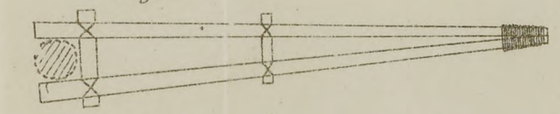


Fig: 8.

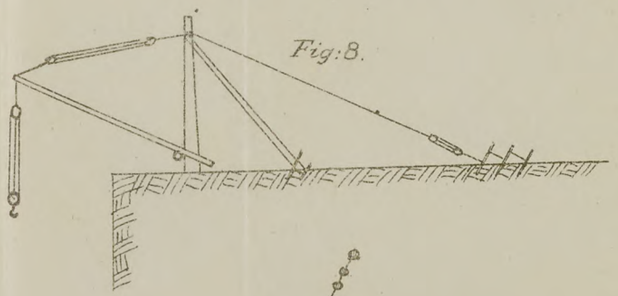


Fig: 9.

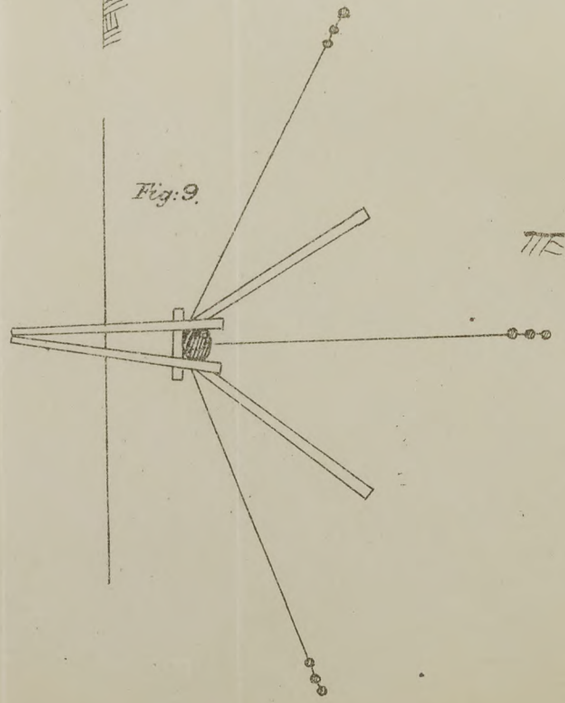


Fig: 6.

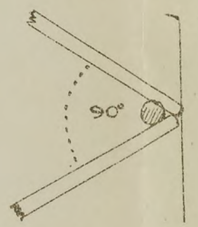


Fig: 7.

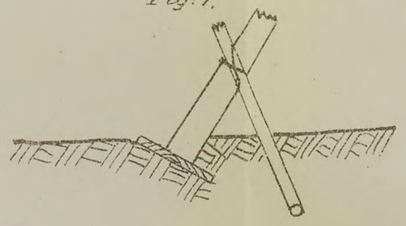


Fig: 10.

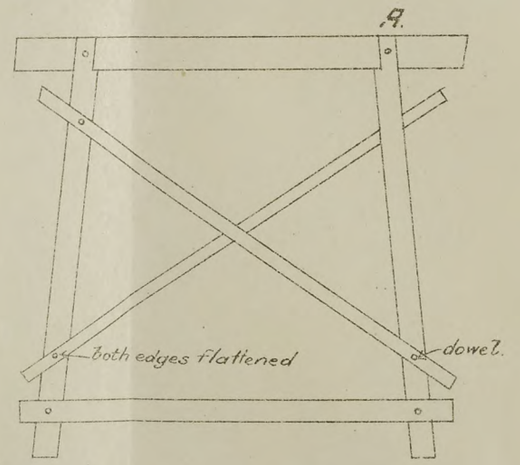


Fig 11.

Detail at A. (Fig: 10)

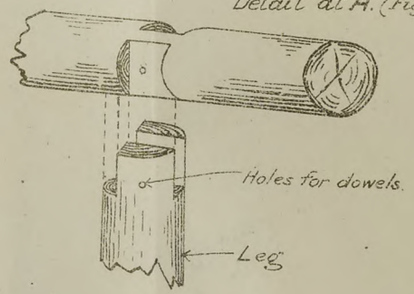
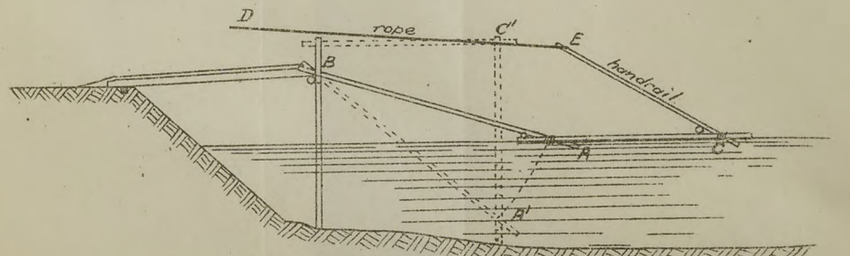
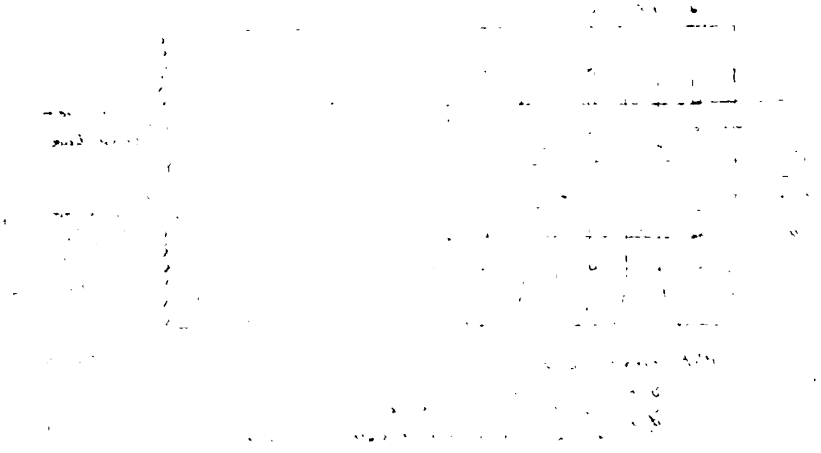


Fig: 12.



Trestle is floated to AC. A light frame AB of two spars diagonally braced is then fixed at A and B. (Rope DE is then hauled on and trestle comes into vertical position at AC.) The frame AB remains as longitudinal bracing A'B. The distance A'B must be obtained from the section.



Digitized by Google

A PONTOON BRIDGE FOR STEAM TRANSPORT.

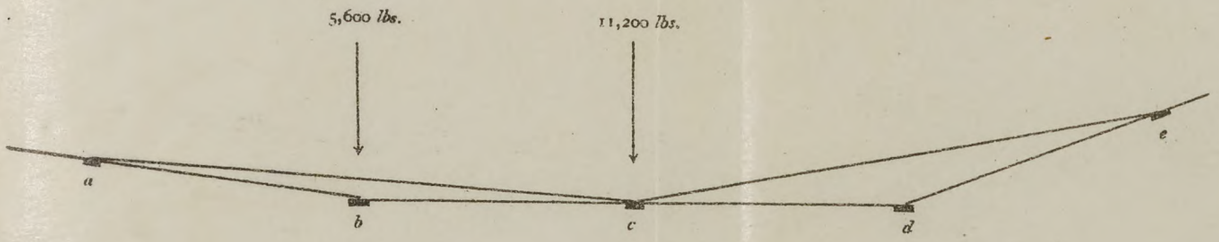


FIG. 1.

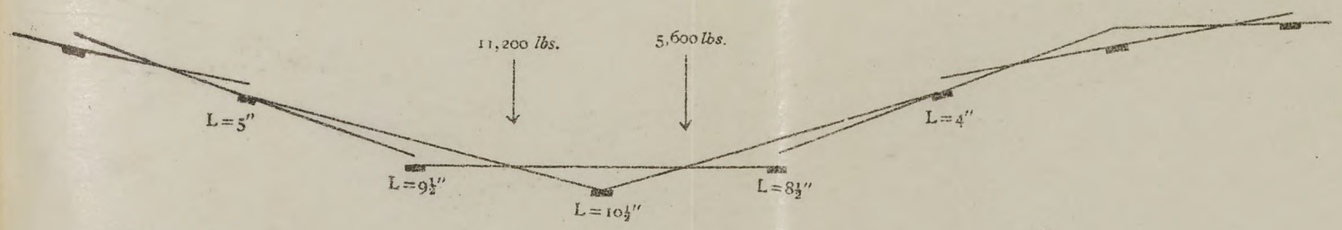


FIG. 2.

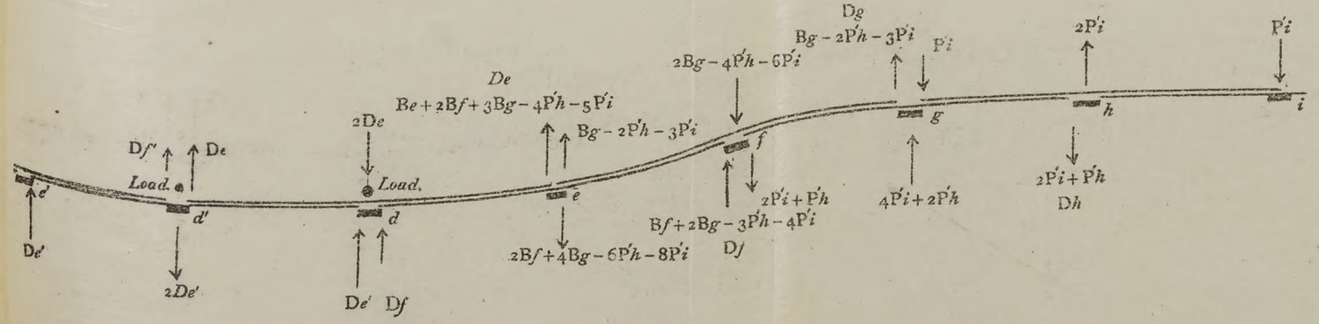


FIG. 3.

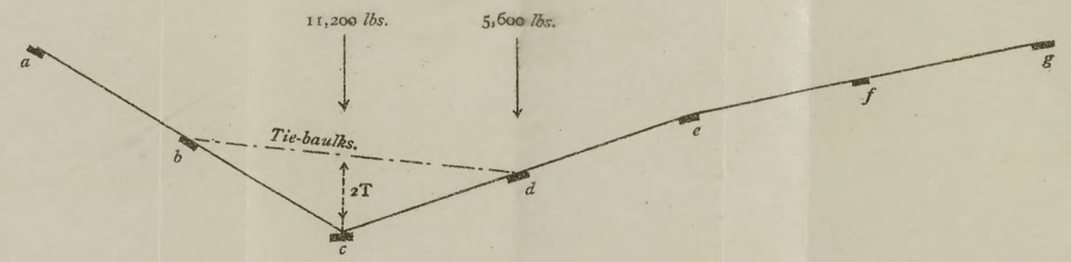


FIG. 4.

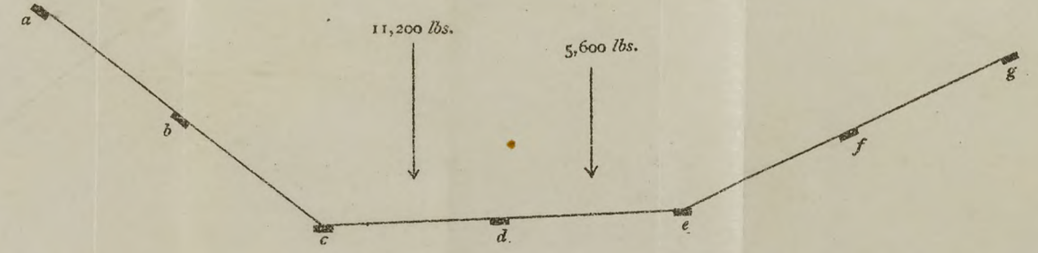


FIG. 5.

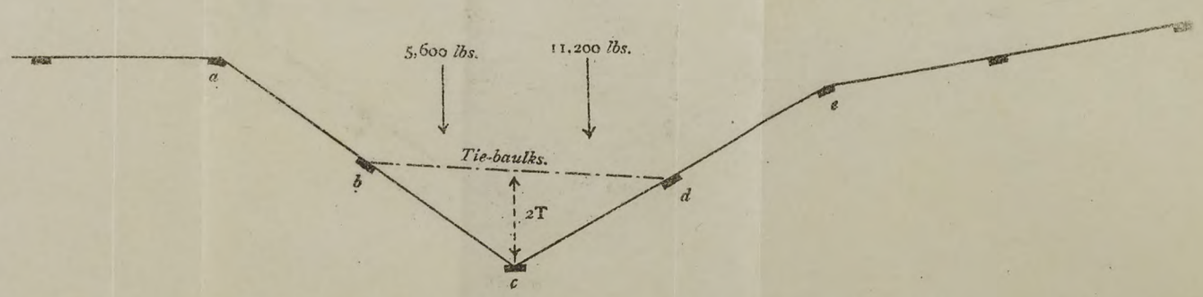


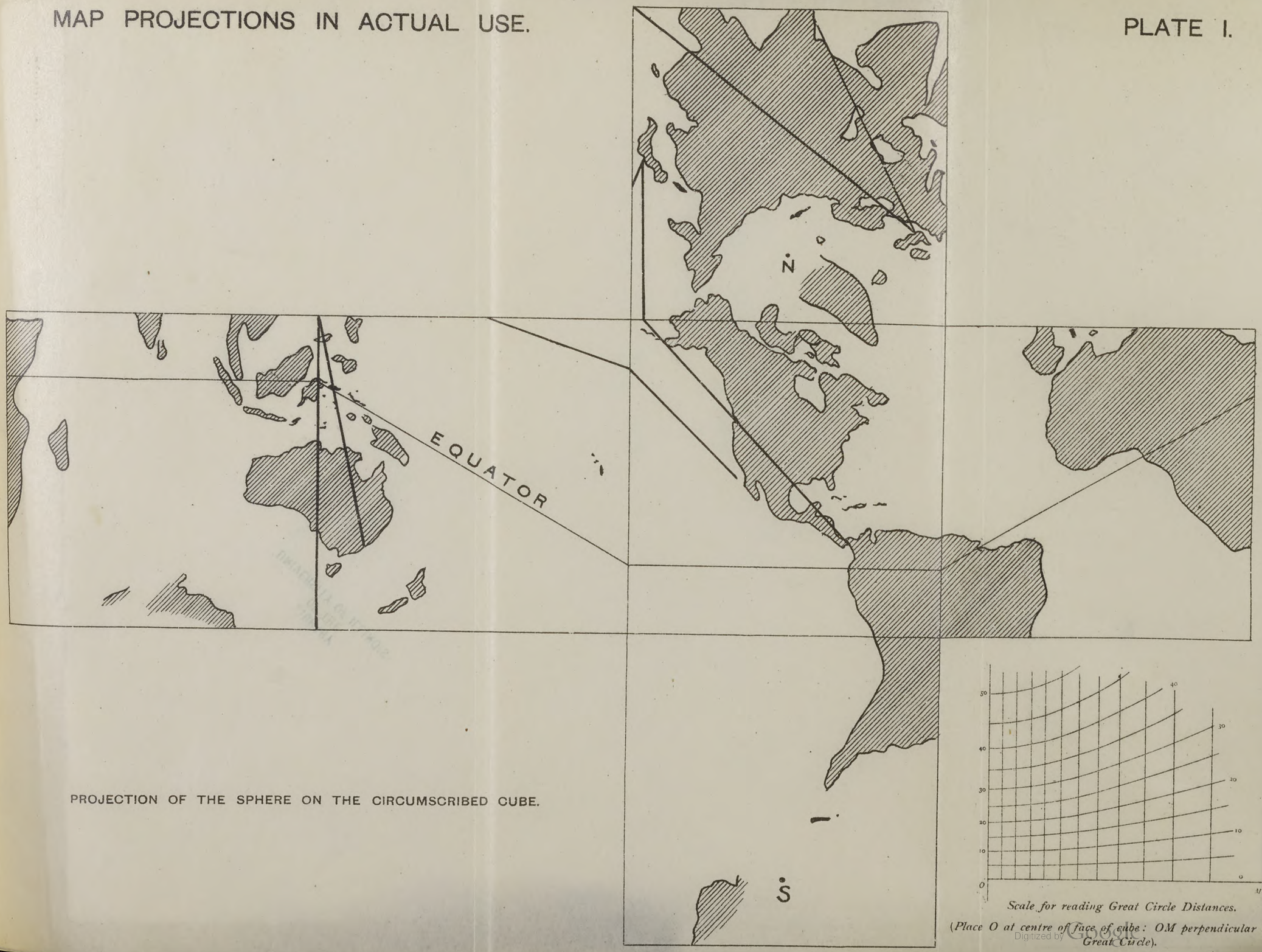
FIG. 6.

Digitized by Google

Digitized by Google

MAP PROJECTIONS IN ACTUAL USE.

PLATE I.



PROJECTION OF THE SPHERE ON THE CIRCUMSCRIBED CUBE.

Scale for reading Great Circle Distances.

(Place O at centre of face of cube: OM perpendicular to the Great Circle).

Digitized by Google

PROJECTION OF THE SPHERE ON THE CIRCUMSCRIBING

Digitized by Google

Digitized by Google

KACHIN BRIDGES.

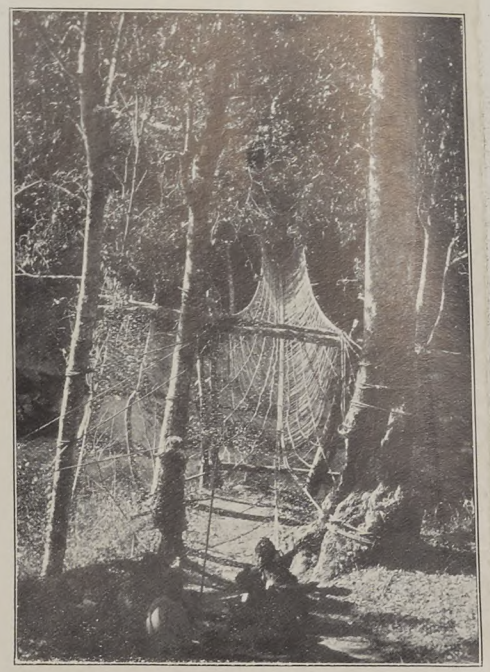


Photo 1.—Kachin Cane Suspension Bridge—End View.

Photo 2.—Kachin Cantilever Bridge of Saplings stuck in ground—End View.

Photo 4.—A good specimen of Kachin Gabion-Pier Bridge (Span about 180', height of Piers over 12').

(Note height of Gabion Piers in relation to the elephant fording the river)

Photo 3—Kachin Cantilever Bridge of Saplings stuck in ground—Side View.

Photo 5.—Kachin Gabion-Pier Bridge, with intermediate trestles.

Digitized by Google

KACHIN BRIDGES.

By Bt. Major R. L. McClintock, d.s.o., R.E.

In the extreme north of Burma, interposed as a buffer between the Burman of the Irrawaddy Valley and the Chinese of Yun-nan, lives a Mongolian race known as the Kachins. Their land being a blend of dense bamboo jungle, raging torrents, and precipitous mountain ranges, and being furthermore almost entirely unproductive of anything of the slightest use to the white man, it has so far been little visited by Europeans. Although largely represented on the map by an area void of anything but the conventional signs for mountains and rivers, it contains a number of villages tenanted by a hardy race of small stature, whose flat faces and oblique eyes lead ethnologists to conjecture that their possessors were originally immigrants from the steppes of Eastern Thibet.

Living amid such conditions of jungle, they have developed a remarkable skill in the use of the "dah" (a two-handed knife, combined tool and weapon), and in the application to useful purposes of the bamboos felled by its aid. Given dah and bamboo, the Kachin will make for himself a plaited belt or a house, a cooking-pot or a bridge. It is of these latter that this article proposes to treat, in the hope that a more general acquaintance with these jungle shifts may haply avert such sad episodes as quoted by Lord Roberts in *Forty-One Years in India*. Readers of that work will remember how, in the Lushai Expedition of 1871, the local coolies completed a very serviceable bamboo bridge across a certain river, while the R.E. officer told off for the job was still making calculations and searching for what he considered suitable material.

The various native bridges met with in the Kachin Hills may be classified under three main heads, though the design of any particular bridge is often a blend of two or more distinct types.

(1). The suspension bridge, made from canes or creepers.
(2). The cantilever, from saplings and bamboos.
(3). The trestle and pier, the former made from saplings and bamboos, and the latter from stone-filled gabions.

The two first are used mainly in the wet season, when every nullah is a roaring torrent. They cross the gap in one span well above high flood level, but are adapted only to carry single passengers. In the dry season, if there be no ford at hand, they are replaced by the third variety which will take all the local traffic including loaded pack mules.

Digitized by Google

(1). SUSPENSION BRIDGES.

For these it is usual to choose a point for crossing where two forked trees can be found to serve as piers at opposite sides of the stream (*vide Fig.* 1). If forked trees, however, are not to be found, two straight ones growing close together will be accepted as a substitute for either pier (*vide Photo* 1), or even posts planted in the ground will be used. Five cables of cane or creepers (which grow to a very considerable length in these jungles and run up to about $\frac{3}{4}$" in diameter) are usually employed to cross the gap. First a double cane, made of two twisted together, is stretched as tightly as possible between the bottoms of the forks of the two trees. This forms the roadway of the completed bridge. Next, two single canes are bound to each arm of each fork. These are also hauled as tight as possible, and are consequently more or less parallel to the roadway cable, the upper cane on each side being about shoulder high above it. These five cables are then linked together with thinner canes, till the whole forms one trough-like system inside which the passenger walks.

If either of the trees forming the piers is not stiff enough to resist the forward pull of the cables, it is stayed back with cane to another tree in rear. Should the forks of the trees (which are, of course, the shore ends of the bridge) be at an inconvenient height above the ground level, shore bays of logs are added to give access to the bridge (*vide Fig.* 1).

This type of bridge may be met with in spans of anything up to 60′ or 80′.

(2). CANTILEVER BRIDGES.

To construct these, two rows of saplings of about 6" diameter have their butts well buried in opposite banks, and their tips (which previously pointed upwards at about 45°) hauled down till they meet and overlap in the middle, where they are then lashed together. This forms an arch of considerable strength. Some half dozen or so saplings thus fixed side by side go to form the roadway, while two or three more, set at a steeper curve, provide the hand rails, the whole being lashed into one system with small canes.

In the bridge shown in *Photo* 3, the centre is seen supported by two poles crossed like a pair of sheers. This extra prop is sometimes added, but as the first flood removes it (like the low-level trestle bridge seen beyond it) without making any apparent difference to the cantilevers, it can hardly be considered as essential.

(3). TRESTLE AND GABION PIER.

Ordinary trestle bridges, the trestles being made from saplings and the roadway from split bamboo covered with a little earth, are used across the smaller streams. By a judicious use of forked poles

Digitized by Google

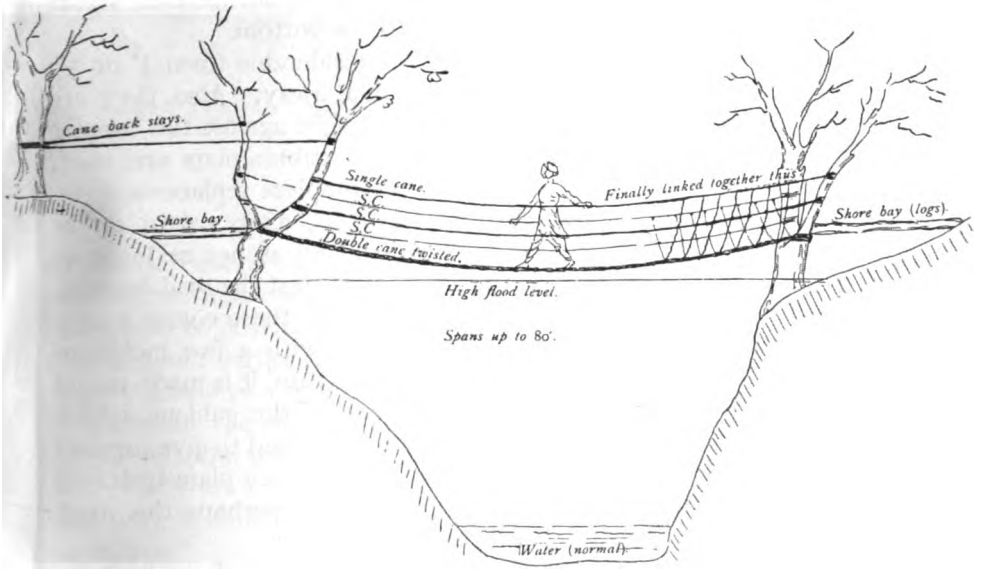


FIG. 1.—*Kachin Cane Suspension Bridge.*

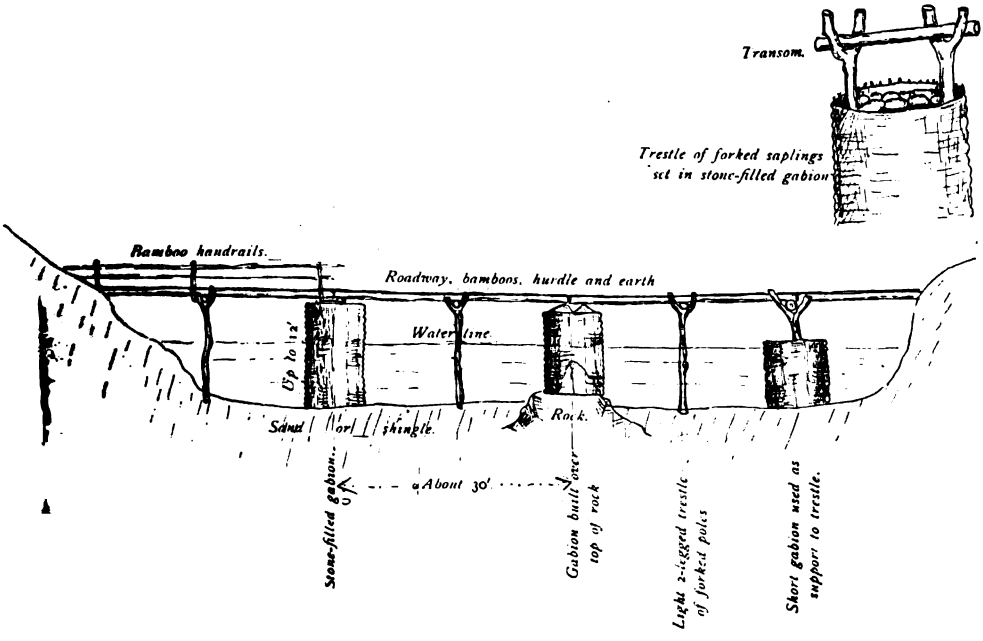


FIG. 2.—*Kachin Gabion-Pier Bridge with intermediate trestles.*

Digitized by Google

for the trestle legs, the Kachin avoids having to use lashings (always unsatisfactory and perishable) for connecting transom and standards. Ledger and diagonals are usually dispensed with, but inclined struts are sometimes used from roadway level to the bottom.

When, however, the depth of water is considerable (over 4′ or 5′) these trestles have a tendency to lift and float away. Also, they are unsuitable for rapid currents. To provide weight against the former contingency, and stiffness against the latter, gabion piers are used, sometimes alternating with, sometimes in complete replacement of, the trestles. These are large bamboo gabions, often 10′ to 12′ in height, and 4′ to 8′ across, completely filled with stones as large as can be conveniently lifted. On the top of these rest the road-bearers, which are saplings or large bamboos, and above these comes a continuous bamboo hurdle, made *in situ*, covered with a few inches of earth. If a large rock should occur in the stream, it is made use of as a combined anchor and foundation for one of the gabions, which is built to enclose it. Sometimes a low gabion is used to give support to a trestle for about half its height, and sometimes a plain trestle is placed between every two gabion piers. This is perhaps the most usual type, and is shown in *Photo* 4 and *Fig.* 2.

This form of bridge is marvellously quickly constructed and uncommonly useful and enduring. It will stand any sort of flood until the water actually begins to wash over the roadway, when the latter is destroyed by the earth washing out, and the road-bearers then floating away. But even then the gabion piers often remain, and the bridge is quickly repaired when the water falls. On the recent Hpimaw Expedition a series of such bridges occurred on the L. of C. of the column, and with very slight repairs served to carry all its pack transport for some five months.

Digitized by Google

A PONTOON BRIDGE FOR STEAM TRANSPORT.

(*Concluded*).

By CAPT. W. L. DE M. CAREY, R.E.

In the February number of the *Journal* four types of bridge were considered under a load of a 7½-ton steam tractor. Design IV. was shown to be unsuitable, whilst Design II. necessitates extra stores and more labour during construction, giving in return no adequate advantage. These two types will not be further considered.

The load, the effect of which has been investigated, is the simplest for calculation, but will not be the usual one in practice. An engine will nearly always be drawing one or more trucks, loaded or empty, and may be following close behind a similar train, ordinary transport, or troops.

Design I.—Using the same notation as before, first consider the case of a tractor drawing one loaded truck, the axles of which are 8′ 9″ apart and each bear a load of 3½ tons. The distance from the driving axle of the tractor to the front axle of the truck is taken as 10′.

Fig. 7 shows this load for Design I. when the driving axle is over a pontoon.

If the baulks were stiff their positions under the load would be as shown in *Fig.* 7*a*, but the baulks *ce* and *eg* being unsupported at the centre will bend, and the ends of the baulks *df* will be deflected upwards with respect to *e* by the forces B*d*, B*f*, until the saddles of the pontoons *d* and *f* touch the baulks *ce* and *eg* and take a portion of their loads.

To find the true positions of the pontoons let x be the pressure that the pontoon *d* exerts on the baulks *ce*; y that of *f* on *eg*; B′ the buoyancy of a pontoon due to immersion I.

Then, considering the baulks *ac* and *bd*

$$3 \cdot B'a + 2 \cdot B'b + B'c = \tfrac{3}{2} \cdot 7840 + (\tfrac{2}{3} 7840 - \tfrac{1}{2}x) + 1500\,(3 + 2 + 1 + \tfrac{1}{2})$$

$$\triangle bd = Ic - \tfrac{1}{2}(Ib + Id)$$

$$\triangle dc = Ib - \tfrac{1}{2}(Ia + Ic)$$

Considering the baulks *df*

$$\triangle df = Ie - \tfrac{1}{2}(Id + If)$$

$$2(B'f - y) + B'e = 11200 + 1500 + (\tfrac{1}{3} \cdot 7840 - \tfrac{1}{2}x + \tfrac{1}{2} \cdot 1500) + (\tfrac{1}{2} \cdot 5600 - \tfrac{1}{2} \cdot y + \tfrac{1}{2} \cdot 1500)$$

Digitized by Google

Since ce and eg touch d and f respectively

$$\triangle ec = \mathrm{I}d - \tfrac{1}{2}(\mathrm{I}c + \mathrm{I}e)$$

$$\triangle eg = \mathrm{I}f - \tfrac{1}{2}(\mathrm{I}e + \mathrm{I}g)$$

Since the total load must equal the sum of the forces "B′"

$$\mathrm{B}'a + \mathrm{B}'b + \mathrm{B}'c + \mathrm{B}'d + \mathrm{B}'e + \mathrm{B}'f = 5\tfrac{1}{2} \times 1500 + 2 \times 7840 + 11200 + \tfrac{1}{2}(5600 - y) + y$$

The load on g is approximately $\frac{1}{2}(1500 + 5600 - y) + 1500$; $\mathrm{I}g$ can be computed from this.

From these equations the values obtained for I when there are 20 baulks are approximately a 5½″, b 11½″, c 16½″, d 18½″, e 17½″, f 13″, g 6½″, and the portion of each of the forces B′f and B′d acting on the baulks df is 5,100 lbs.

When dealing with the load of a tractor only, it was shown that I for the corresponding pontoon was 10¾″, and B′ 5,750 lbs., *i.e. by adding a loaded truck behind the tractor the maximum stress in the baulks under the load has been reduced.* It may therefore be expected that by adding more trucks this stress will be further decreased, especially if the tractor is close to other trucks preceding it.

For the sake of calculation, the portion of bridge under load considered must be small. *Fig.* 8 shows such a portion bearing an engine with two trucks on each side. From the results of the investigation of this case, the effect of a continuous load of steam transport may be deduced.

Assuming the baulks to be stiff the values of I for the centre pontoons would be e 16″, f 17½″, g 17⅓″, h 17″, i 16″.

The distance between f and the centre of eg and between h and the centre of ig would be 1″ and ⅓″ respectively but, as before, the deflection of the baulks will cause f and h to touch eg and ig.

Calculating in the same manner as in the previous case, it can be shown that the values of I for the several pontoons are

a 7½″	d 15⅓″	g 16⅔″	k 14¾″	n 13″
b 12½″	e 15⅔″	h 15½″	l 14¾″	p 7½″
c 15″	f 16½″	i 14¾″	m 14¾″	

and the stresses in the baulks under the centre of the load, will never be greater than when the heaviest axle is in the centre of a span.

There will however be a stress in the baulks at the ends of the load, caused by the forces B′a B′p, which are only *directly* opposed by the weight of the superstructure above them. These forces will vary as the weight on the last axle of the load, being in the present case

Digitized by Google

3,700 lbs. approximately, and therefore causing a bending moment in the baulks in question of $(3700-1500)\times 7'\ 6''$, *i.e.* just within the limit of safety of 5 baulks.

These last stresses can be avoided by having a continuous load across the bridge or by having loads gradually diminishing towards each end, *e.g.* by having ordinary transport or troops on the bridge close in front and behind the steam transport.

The heaviest axle (11,200 lbs.) can be carried by 8 baulks but as 3 have to be grouped under each wheel track, 9 or 10 are necessary in order to support the chesses at other points.

It therefore appears that this type of bridge can be constructed with 9 baulks, if traffic is to be regulated, but otherwise needs 20 baulks to be strong enough for all contingencies.

Design III.—In this type of a bridge with a load of a tractor and one truck the values of B in the four cases can be calculated in the same manner as for a load of a tractor only.

In Case 1, the maximum value of I exceeds $18\frac{1}{2}''$ (*i.e.* freeboard of $7\frac{1}{2}''$) and tie-baulks at $3\frac{1}{2}''$ clearance must be used to obviate this. This is shown in the following table :—

	Case 1.				Case 2.		Case 3.		Case 4.	
Position of Driving Axle.	Over *e* (*Fig.* 9).				Between *e* and *f*.		Over *d*.		Between *d* and *e*.	
	With Tie-Baulks.		Without Tie-Baulks.							
Pontoon.	B.	I.	B.	I.	B.	I.	B.	I.	B.	I.
a	140	$3\frac{1}{4}''$	376	$3\frac{2}{3}''$	−879	$1\frac{1}{2}''$	3623	10″	1362	$5\frac{2}{3}''$
b	3583	10″	3014	9″	2589	8″	5677	$14\frac{1}{3}''$	4570	12″
c	7026	17″	5651	$14\frac{1}{3}''$	6257	$15\frac{1}{2}''$	7731	$18\frac{1}{2}''$	7778	$18\frac{1}{3}''$
d	7405	18″	7896	$18\frac{2}{3}''$	7111	$17\frac{1}{3}''$	7047	17″	7686	$18\frac{1}{3}''$
e	7783	$18\frac{1}{3}''$	10142	$23\frac{1}{3}''$	7764	$18\frac{1}{3}''$	6363	$15\frac{2}{3}''$	7594	18″
f	4661	$12\frac{1}{3}''$	5162	$13\frac{1}{3}''$	5709	$14\frac{1}{2}''$	2633	$8\frac{1}{3}''$	3625	$10\frac{1}{3}''$
g	1540	6″	186	$3\frac{1}{3}''$	3454	10″	−1097	1″	−344	$2\frac{1}{3}''$
	T = 2756 lbs.									

The maximum bending moment is 7,000 lbs. × 3′ 9″ at *e* in Case 2 which is slightly less than the maximum when the load was a tractor only, and as before, 10 baulks are necessary as road-bearers, and 4 as tie-baulks. The effect of deflection is negligible, it being less than $\frac{3}{4}''$ in any baulk.

Fig. 10 shows a load for this design of bridge corresponding to that in *Fig.* 8.

Digitized by Google

The following table gives the values of I and as before in Case 1 tie-baulks are necessary but with 2″ clearance only.

	Case 1.		Case 2.	Case 3.	Case 4.
Position of Driving Axle.	Over *i*.		Between *i* and *k*.	Over *k* (*Fig.* 10).	Between *k* and *i*.
Pontoon.	With Tie-Baulks.	Without Tie-Baulks.			
a	$2\frac{1}{2}$″	$2\frac{1}{2}$″	3″	$\frac{1}{4}$″	—
c	$5\frac{1}{2}$″	$5\frac{1}{4}$″	$3\frac{1}{2}$″	$16\frac{1}{4}$″	$10\frac{3}{4}$″
e	18″	$18\frac{1}{4}$″	$15\frac{1}{4}$″	$14\frac{1}{4}$″	$15\frac{3}{4}$″
g	$14\frac{2}{3}$″	13″	$16\frac{1}{2}$″	18″	$17\frac{1}{2}$″
i	$18\frac{1}{2}$″	$21\frac{3}{4}$″	18″	$15\frac{1}{4}$″	$16\frac{3}{4}$″
l	$14\frac{2}{3}$″	13″	$13\frac{1}{2}$″	14″	$15\frac{1}{4}$″
n	$14\frac{1}{3}$″	$14\frac{3}{4}$″	$17\frac{1}{2}$″	18″	16″
r	$16\frac{1}{4}$″	$16\frac{1}{4}$″	$15\frac{1}{4}$″	$5\frac{3}{4}$″	$10\frac{1}{2}$″
t	$\frac{1}{4}$″	$\frac{1}{4}$″	$3\frac{1}{2}$″	$2\frac{1}{2}$″	—
	T = 1,850lbs.				

The maximum stress in the baulks in any of these cases is that caused by the driving axle in the centre of a span. The effect of deflection on the positions of pontoons is negligible, the greatest being $\frac{3}{4}$″ in *gi* in Case 3, and $\frac{1}{2}$″ in *ce* in Case 1. Design III. can therefore be constructed for continuous or gradually diminishing loads with 9 baulks as road-bearers and 4 as tie-baulks (lashed at their centres).

Comparisons of Designs.

Providing that the practical details of securing the tie-baulks do not prove a difficulty in Design III., both types of bridge will be of use, being suited to different circumstances which may be summed up as follows :—

1. If time and material are no object.
2. If water is rough and freeboard is all important.

} Design I. with 20 baulks.

3. If material is scarce.

} Design I. with 9 or 10 baulks and traffic regulated.

4. If time is all important.
5. If the bridge has to be made from rafts.

} Design III., 2nd pontoons and tie-baulks being added whilst the troops are crossing.

6. If transport cannot be regulated and material is limited.

} Design III., with clearance of tie-baulks regulated for single heavy loads.

Digitized by Google

Design I. causes more deflection in the baulks than Design III. which is a disadvantage from the point of view of wear and tear, and liable in time to make the baulks fail under the horizontal shearing stress.

Details of Construction.

Tie-Baulks.—It has been assumed in investigating Design III. that extra baulks which have been called "tie-baulks" were so arranged that the amount the pontoons under their centres could sink below the adjacent pontoons was limited to some fixed distance.

There are three ways of carrying out this arrangement.

Firstly; by placing the baulks as ribands and securing them to the saddles below them, at their tips by light lashings, and at their centres by lashings strong enough to take a strain of 5,500 lbs. (eight complete turns of an $1\frac{1}{2}''$ lashing are necessary) and made loose enough just to give the amount of play determined on.

Secondly; by placing the baulks beyond the roadway, and after blocking them up the necessary amount from the gunwales of the pontoon they are to support, lashing them by turns passing under the pontoon. This will take 15 fathoms for each lashing (*i.e.* two $1\frac{1}{2}''$ lashings per pontoon in the bridge) but will save $\frac{1}{3}$ of the tie-baulks, as has already been shown.

Thirdly; by placing the baulks on the projecting ends of the saddles and lashing them either as in the first case or, after blocking them up the necessary amount from the saddles at their centres, lashing them tightly there and leaving the ends unlashed.

Each method has its advantages but the first seems the most practical, its chief disadvantage being the necessity for notching the chesses to allow the lashings to be made.

Adjustment of clearance can be made in all cases by making the centre lashings to suit the greatest clearance ever to be required and inserting chocks to reduce it to that required at the time.

It may with reason be argued that the extra factor of safety for live load need not be as great for tie-baulks, as for road-bearers, because the strains on the former are more gradually and only indirectly applied. On this assumption, a bridge of Design III. with 10 baulks and 4 tie-baulks (*i.e.* for continuous loads) would carry any traffic except a steam tractor alone without alteration of the clearance of the tie-baulks.

Racking and Ribands.—The calculations for Design II. and for tie-baulks give some idea of the strains that may be brought on ribands, and to avoid this only pliable material should be used for the purpose, or else racking should be loose. Furthermore the stress in a riband increases, in some cases, the stress in the baulk it is racked to, by tending to even up the levels of the pontoons.

Digitized by Google

Chessing.—Double chessing is not a necessity as regards strength when baulks are grouped under the wheel tracks, and it would be more economical as regards wear to single chess only and add wheel tracks, made either of chesses, or better, of any suitable material that could be obtained on the spot and discarded when worn out.

Conversion of Medium Bridge to Heavy Bridge of Design III.—The second pontoons can be floated into place without their saddles by loading them up with men, and the saddles with their cleats under the correct baulks may be slid into position from the side of the pontoon.

If the road-bearers and chesses have to be added to, the necessary numbers for each bay can be placed on the gunwales of the pontoons, and every alternate 15′ length of the bridge can be simultaneously unchessed, have baulks inserted, and be double chessed.

Traffic would be interrupted for less than 10 minutes, and if the full number of road-bearers were available for use when the bridge was being built, there need be no interruption at all.

Forming from Rafts.—15′ rafts can be constructed with the full number of baulks and chesses for the finished bridge, and with three pontoons, the fourth, necessary for the space between two rafts when in bridge, being towed.

Forming Up.—When forming up there is a trouble in placing baulks that does not occur in the present type of bridge. The cleats on the saddles of three pontoons covered by any set of baulks must be accurately in line or the baulks will not fit. In rough water or where there is a strong current it is very hard to hold the pontoons in position even for the short time necessary to place the baulks, and if the centres of the outer baulks are not placed in the correct cleats, the centres of one of the inner baulks may come over a space between cleats too narrow to give it a bearing.

This can be avoided in Design III. by having the saddles of the pontoon under the centre of a set of baulks loose, and securing it after the baulks are placed.

Cuts may be formed in either type of bridge with 10 road-bearers by making a slight modification in design, but with more than 10 road-bearers there is not room for the extra baulks necessary.

The cut-raft in both types of bridge should be a 5-boat section constructed on the lines of Design III.

In Design I., the baulks, the centres of which rest on the last pontoon in bridge, must be replaced by ribands. In Design III., five ribands in addition to other road-bearers would have to be placed in this position.

The cut-baulks are placed on the cut-raft.

To form cut; after pushing back the cut-baulks, the 5 riband-roadbearers are slid back under the superstructure of the raft in bridge. The tie-baulks over the end pontoons of the cut-raft can be

Digitized by Google

slid back clear of the rafts in bridge at leisure, when the time to form cut approaches, provided that steam transport is not crossing at that moment.

Shore Ends.—When trestles have to be used at the shore end of a bridge, in order to get an even bearing for the baulks resting on both trestles and pontoons, special arrangements are necessary.

The system of breaking joint with baulks (Design I.) is obviously not suited to more than the slightest change of slope, and the variation between the levels of the bridge loaded and unloaded will be more than enough to upset the bearing of the baulks that rest on a trestle.

Take a case where one trestle is necessary between the shore transom and the first pontoon. If the transom of this trestle is adjusted to the level of the unloaded bridge, as the first axle of a load passes it, the first pontoon will sink and leave the baulks on its shore side acting as cantilevers.

To avoid this, a second trestle can be placed a foot from the first (*Fig.* 11) to receive the ends of the baulks *b'd* its transom being adjusted $1\frac{1}{2}''$ to $2''$ above the general level of the bridge when under its heaviest load. The transom of the original trestle to be placed at a level half-way between the loaded level and the unloaded level of the bridge. The baulks *ac* must always be the full number in a bay, *i.e.* between *b* and *c* in Design I. there will be half again as many baulks as in any other bay.

In the case of Design I. with 20 baulks and a tractor coming off the bridge alone, the 20 baulks are strong enough to carry the driving axle in the centre of their span. In the case of a bridge of 10 baulks (Design I.) the tractor will be followed by trucks and the pontoon *c* will be at such a level that the baulks *ac* are just bearing on the trestle. As the driving axle comes to *c* and starts up the incline *cb*, the pontoon *c* will tend to sink, but will be prevented from doing so by the baulks *b'd* taking the extra load.

For Design III. the best arrangement would appear to be to have the baulks from *b'* to *d*, *d* to *f*, etc., when the shore end would act as in Design I. If the baulks are placed from *c* to *e*, *e* to *g*, the tie-baulks from *c* would rest on *b'*.

In this type of bridge, if a tractor is to cross alone the clearance of the tie-baulks throughout the bridge needs adjustment and the transoms *b'* and *b* can be adjusted at the same time.

Tidal ramps may be constructed with trestles 7′ 6″ apart, but not with baulks breaking joint owing to the changes of slope necessary. The deflection of the baulks under load will take up any small errors in adjustment of the transoms.

An experimental heavy bridge with pontoons at 7′ 6″ centres was constructed at Wouldham last autumn, of which a portion was loaded till there was a freeboard of 12″. The bridge was swung

Digitized by Google

successfully both with and against the current, which was flowing at $2\frac{3}{4}$ miles per hour, showing that the obstruction to the waterway by the intermediate pontoons is not so great as to cause too heavy a strain on the anchors. No test for the strength of baulks could be made as the heaviest vehicles available were pontoon wagons, but valuable information might be obtained from such tests by noting the deflection of a set of baulks for various positions of the load. If the concentrated dead load which could cause such a deflection is less than the safe *live* load for the same length of span, the baulks are not being strained beyond their safe limit.

Cuts were made in the manner previously mentioned but without tie-baulks, and in consequence there was a tendency for the end pontoons of the cut-raft to sink more than other pontoons when the load came over them. The time taken to form cut was only half a minute longer than in the case of "medium" bridge.

Digitized by Google

THE LATEST DEVELOPMENTS IN MUSKETRY.

A Lecture delivered at the S.M.E., Chatham, by BRIGADIER-GENERAL W. N. CONGREVE, V.C., C.B., M.V.O.

I FIND myself put down to address you on the subject of "The Latest Developments in Musketry," and when I first heard my subject I said to myself,—But there are none!

Consideration, however, and looking back over the last two years, convinced me that things have moved to some extent during my time at Hythe, and that it is only their gradual growth following naturally from the system started by my predecessors—Generals Monro and Egerton—that prevented me from seeing them at the first glance; at the same time there is nothing which can be called new.

"Developments" is the exact word wanted, and I propose to bring some of these to your notice. To do this, I must more or less go through the whole subject of musketry.

The first consideration is, do we now, in these days of flat trajectory, long-range rifles, collective fire, and an often invisible enemy, require a high standard of individual skill? Many people have said we do not, and the Japanese, I believe, set little store by it—so little indeed that our 2nd Class shot is about equal to their marksman. There are two arguments which I think quite convincing in its favour,—

(1). That confidence is bred by it, and terror by its absence.
(2). That it is essential for instructors, a man being believed in in the ratio of his own skill.

Your work as sappers will often put you in small isolated detachments, and for you, skill with the rifle is, I consider, an enormous asset worth any effort to attain.

Being then agreed as to the necessity for a high standard for the individual,—how is it to be obtained? Ranges are often difficult to get to or non-existing, and ammunition is little and very expensive. Barrack square work—miniature ranges and 30-yard ranges, supply the deficiency. In all these, we have advanced to some extent, and we have proved that men thoroughly trained by such methods have really very little more to learn as far as individual proficiency goes. Even the miniature range alone goes far to make an accurate bull's-eye shot which, mind you, up to 1902 was nearly *all* we aimed at. The Secretary of Lord Roberts' Society of Miniature Rifle Clubs told me only the other day that lots of their clubs can produce men to

Digitized by Google

compete on equal terms at bull's-eye shooting on the open range, and at distances up to 800 yards, with any team in the kingdom.

It would take too much of the time at my disposal to go into all the details of the improvements made in these above-mentioned methods of training, but I would mention new landscape targets, accurate ammunition and rifles for miniature ranges, improved apparatus for working targets, perfection of the Solano target, and improved construction of the 30-yard ranges.

The great point about all these things and any other odds and ends of contrivances, is that they tend to keep the men's interest, and prevent them from being bored—a very important matter if good results are to be expected.

I am not concerned in the firm, but Messrs. Graham & Latham of Charing Cross are about the best people for all range appliances, and I advise anyone fitting up a miniature range to send for their catalogue. At the same time, we claim to provide all they do with the standard patterns, shortly, I hope, to be in Part II., *Musketry Regulations*, and invented by Capt. Hobbs, R.E. These cost enormously less, but certainly are very rough and less attractive. I so often see miniature ranges in a most neglected and unattractive state for which there can be no excuse, for a little initiative and a little money (very little) will put them all right. Hythe is always ready to give the benefit of its advice, if people will only ask, and they certainly will save money by doing so.

I find some units do an enormous amount of voluntary night practice on miniature ranges, and the non-commissioned officers and men quite keen about it. But for this you must make the range attractive with smooth working and, most essential, good lighting.

Before I leave the question of the individual, I would say a word on eyesight.

I am often told that our standard of vision admits men to the Service who are physically unable to aim, but the Americans have proved that soldiers artifically blinded by glasses to a standard considerably below our rejection limit can still shoot almost as well as with their normal vision, and not only shoot but pick up targets on the field. When therefore you get a recruit who pleads bad sight for his bad shooting do not attach too much importance to it for in most cases patience in the instructor and will power in the man will overcome the difficulty.

Now we will pass on to the next consideration in training, which is the teaching for collective fire rendered necessary by the inability to see service targets, or the strike of single bullets beyond close range. Men who have not considered the question are apt to say that the only proper system of training is at the bull's-eye, and that the individual is useful up to 1,100 yards or even more. Well, for such people a very simple cure is to show them a practical demonstration

Digitized by Google

such as shooting at head and shoulder targets at successive ranges from 400 yards to 800 yards. I have never known it fail.

Collective fire is, as you all know, the power to co-ordinate the fire of individuals at the will of one; to get the maximum result from it requires a highly trained commander, with a knowledge of what we call the error of the day—of ground, and of tactical considerations which influence fire—and of methods necessary to place the shots of his men where he wishes.

From the men we must expect ability to hold steady, aim, and let off correctly, and appreciate from their commander's description the place he wishes them to hit. It really, as far as their part goes, may be summed up in the word "discipline."

The Spectator lately said, talking of the Italian-Turkish War,—"Fire control is the first proof of military discipline." My experience is that in this particular point we have very much to learn. Men can now shoot well as individuals; their ability to kill dummies and knock down plates is generally of a very high order; but there it ends—whereas it should be the beginning.

It is no use if kept for range practices; we must insist on careful aiming and careful positions, and careful fire orders at all times, and especially at manœuvres; it is when men are tired that discipline shows, and what we have got to get from the men is such a discipline as shall make correct sight setting, aiming, and firing, a habit under all circumstances, and from fire unit commanders, a perfect control of fire, and an ability to see what is wrong and have it put right.

Now, how are we going to get these things? We are again brought up by want of ammunition and of ground, and again we must have recourse to substitutes, such as barrack square training, miniature ranges, and 30-yard ranges. On these, with the help of landscape targets, magic lantern targets, Solano, and Sykes targets, a very great deal can be done.

There is no need for me to go into details of any of these except the Sykes target and the lantern target, which may not be familiar to you. The former has only lately been brought to my notice by Colonel Mark Sykes, M.P. It consists of a miniature theatre stage, with wings and drop curtain; the stage is covered with sand, which can be modelled to make a landscape, on which are placed models of houses, churches, bridges, trees, etc., made to scale according to whether in foreground or background. The ground is coloured with a sprinkling of dyed sawdust of colours required by the picture. A landscape target is in fact actually made. Fire can be opened on it, all bullets being caught by the sand, and miniature targets scaled to distance can be placed anywhere on the picture. The use of the drop curtain is for competitions; each commander in turn is given a landscape and can place his force where he pleases on it; the curtain is then raised and the opponent has to find and engage the enemy

Digitized by Google

within a given limit of time. One of these targets has been erected at Hythe and we shall be very glad to give any information as to measurements and costs.

The lantern idea is the product of Capt. de Putron's visits to Territorial Force, and seems to promise well, particularly for work at night, and putting in practice the competitions in collective firing which have been found to be popular.*

By such means as these we can go a long way towards making up for lack of ground and ammunition, and I am confident can produce well-trained leaders and firers without going to a full-sized range at all, but you must so arrange that musketry is made a part of all your work and not kept apart as such.

Before I leave this part of my subject I would mention the points that we are weakest in and must amend if we are going to do any good in war. They are, in the men, bad aiming at service targets, bad positions when at field firing and manœuvre, bad recognition of targets through idleness or want of training; in the fire unit commanders, inability to give good orders, and slackness in checking faults. If we do not see to these in peace, assuredly we shall get failure in war.

Before I go to the last part of my subject, which is how we are to make the best use of the perfectly trained instrument when we have got it, I would say a word on machine guns, for they can hardly be left out in any considerations of musketry.

We have, I am thankful to say, thanks very largely to my chief instructor—Colonel Campbell—caught up our leeway and are abreast of foreign nations in this particular. Now we have got to get ahead of them in the same way as I believe we are ahead of them in rifle fire.

It can be done, but only by a determination to have the best possible training and by clear thinking as to how guns will be used in war; but what most concerns you is how they are to be opposed when met. So far, we think the chief considerations are to avoid giving a good target—to avoid places which will afford observation of fire to the gunners, for it is everything to a machine gun to get the correct range owing to the close grouping of its fire compared with that of riflemen—and if you are caught in close order, scatter, take cover, and concentrate fire on each gun in turn to destroy it. I have no time to go into the subject properly, for it is a large one, and a very important one, but I could not avoid mention of it in any question dealing with firearms, for I am certain it is going to develop

* The lecturer then showed a few slides to illustrate the possibilities and pointed out that any clearly defined lantern slides of landscapes will answer the purpose. Those giving clear detail of objects within 1,000 yards are desirable. The lantern should give very clear definition and have a focal length exceeding 15 yards, which is the minimum distance for miniature range shooting.

Digitized by Google

enormously, till some day we shall see each company in possession of machine guns.

Having now considered the methods by which we can get fire applied exactly where we want, let us consider a few points of its tactical handling.

I do not propose to go into matters which are already detailed in *Infantry Training* and *Field Service Regulations;* the former are new, and a huge advance, from our point of view anyway, on anything we have had before.

There are, however, a few points which are worth bringing to your notice before I finish.

First, as regards the regulations themselves, we must use common sense in interpreting and applying them, but there are certain things which admit of no variation, and these we have got to get our men to use as a habit, so that when bullets are thick and all control has become impossible, they will still do the right thing, as it were, automatically.

In this particular matter of which I am talking to-day, sight-setting, aiming carefully, and firing correctly, using cover properly, and always advancing when opportunity offers, are the things which have to become second nature, and they are all grouped together under the words Fire Discipline. We can only get it by stiffening up discipline until men find that it does not pay to do wrong—nothing else will make the habit we want.

Next I would mention reconnaissance, because it is most neglected. It applies to everyone, from the Commander-in-Chief to the private soldier; every commitment of troops must be preceded by reconnaissance, and before every advance the same. Battalion commanders, company commanders, section commanders, for all alike it is essential, for so only can proper use be made of ground and of fire. How often at manœuvres do we see men crowded together in a firing line and unable to see any target, or supports lying exposed to the enemy's fire and unable to reply to it owing to their front being masked by other troops. There is no penalty for such things at manœuvres, but a very terrible one will be exacted when it comes to war. It is always due to the want of reconnaissance and thought before moving. Remember, however, that to do it properly takes time, and so give the necessary time for it, and do not hustle your subordinates unduly but insist on a reasoned course of action in every case.

There are five points to be considered before fire can be opened:—

(1). Volume, which is of course dependent on the number of firers, and the rate at which they fire.

(2). Whether fire is to be concentrated or distributed, the maxim being to concentrate for decision, to distribute to neutralize.

Digitized by Google

(3). The range and elevation required, which latter does not always agree with the range ; wind, altitude, temperature, may all affect it.

(4). Allowance required for the error of the day, and the point of aim, which latter alone should be mentioned, irrespective of the target itself.

(5). The description of the point of aim, so that all can recognize it.

Since the whistle has been stopped as a signal for ceasing fire, the problem of how fire is to be stopped is rendered more difficult ; I suggest for trial, to name the number of rounds invariably, and to train someone in each section to look out for the commander's signals.

In an advance under fire, whether it be artillery or rifle, we have to present the most difficult target to the enemy, and this is believed to be the simultaneous advance of a number of small bodies from constantly varying parts of the attacking line ; in other words, an "ordered disorder"—a thing very hard to arrive at, and requiring much practice.

Our object must be to keep our men in hand as long as possible, for once they are extended, the power of manœuvre is gone.

The best cover is bullets, therefore every advance must be covered by fire ; the advance of a company by another company ; of a section by another section ; of two men by another two ; the principle runs right through, and when we at manœuvres see bodies of troops advancing and no fire, we may be sure it is unreal and could not be done in war. The *raffales* of artillery should be the signal for infantry to rush forward and gain ground.

The question of the advance is difficult ; it must of course depend on the volume of the enemy's fire, but the guiding principle should be to push forward the greatest number that the covering fire will permit of. Still more difficult again is the question of length of advances—they must be regulated by the fire positions, and not be a question of so many yards. Advance from fire position to fire position and get to each new one as quickly as possible ; avoid crowding and dead ground from which you cannot fire. Rise quickly and lie down quickly. The Japanese found their greatest losses were when halting and starting again ; as the result of their experience they try to keep their men on their legs as long as possible. Avoid aiming marks for the enemy and hedges or ditches oblique to the enemy's fire. Look out for opportunities to help neighbouring troops forward, but in such cases leave some men to keep down the fire of those in front whose fire you have mastered. If at any time there is a lull and you have opportunity, use it to reconnoitre lines of advance in every direction, for you can never tell in what direction the next advance may take you.

Digitized by Google

Then come the final stages when control ceases to be possible and men have to work forward themselves until they reach a position from which, with a line of maximum density, they can beat down the enemy's fire and obtain such superiority of fire as will permit the assault to be delivered; the only alternative is to entrench and wait for nightfall to carry out the assault.

Throughout an attack there will of necessity be much confusion and mixture of units, therefore every opportunity must be taken to re-form and reorganize; constant practice will be required in accustoming men to act under the nearest section commander, no matter to whose section they may belong.

A final consideration is whether it is possible to deliver fire in movement in order to get over the last few hundred yards in delivering the assault; it has been done, and is practised by some armies still. Our own regulations are silent on the question, but it is one worth consideration, for to leave the enemy unmolested seems to give him an opportunity to again get his head up and fire at us without any danger to himself.

I referred a moment ago to work by night. It seems likely that perfection of arms and modern fieldworks may make attacks by day too costly to be undertaken. Moreover, modern systems of communication and the extended front of battles have made it possible to repair the losses and disasters of day by working at night, bringing up fresh troops, or retiring to a new and previously prepared position.

These considerations seem to demand more action by night so as to prevent the rest of darkness causing a loss of all that has been gained by day, and we must therefore consider how we are going to act. Our regulations go fully into the question. Working on miniature ranges lighted by acetylene gas or some other powerful illuminant, has been found by the Austrians to be a great help in training to pick up targets, and hit them when working with search lights.

Search lights are all very well for the defence, but inpracticable for the attack, which will, I hope, be our *rôle*, so we must consider the matter from that point of view.

We think that men can be trained to an automatic alignment, so that on throwing the rifle up at the flashes of the enemy's rifles they will, though they can see neither rifles nor sights, put a fair proportion of bullets near the enemy, but to get this automatic alignment requires very constant practice. We have tried it, and got some encouraging results, but not enough yet to speak authoritatively, for we have yet to compare those results with others obtained from untrained men.

Remember that whenever fire is employed at night, men must be left to themselves—to choose their own targets, rate of fire, and sighting, for control will be impossible. Therefore high fire discipline and the judgment learned from experience is essential. Austria has

Digitized by Google

begun to recognize this, and has undertaken regular field firing by night. I am bound to say it reads a little theatrical, but they claim to have learned a good deal. The chief point brought out is, I think, the tendency to shoot high, so that in any exercise of the sort it is necessary to put sights several hundred yards below the normal, and this applies equally to shooting by search light.

I have lately been staying with General Gorringe, a very distinguished member of your Corps, and told him I was coming here to-day. He said "Tell them always to remember that they are soldiers first and engineers after." Well, gentlemen, if you accept that saying then you must accept my idea of the primary importance of skill with the rifle *Infantry Training* says "The rifle is by far the most deadly of the weapons with which soldiers are armed. In recent wars it has been responsible for 85 per cent. of the total loss in battle." Another authority has said that 75 per cent. of the fire in battle is misdirected, and there is the old saying it takes a ton of lead to kill a man, which show how far armies in the past have been from anything like high training. It lies with us to attain a better standard than anyone else has. We can easily do it, for we have more ammunition than any other army and we keep our men seven years against others two. But it is in the hands of us officers; if we are content with a low standard we shall certainly have it and we shall still expend an enormous weight of metal in killing one man. Our numerical inferiority seems to make it essential for us to grasp every means which may in any way counterbalance it, and if you think the matter over you will I feel sure agree with me that perfection of fire action promises the best hope for us.

Digitized by Google

NOTE ON THE GRAPHIC CHART.

SHOWING THE SCANTLING AND NUMBER OF ROAD-BEARERS OF VARIOUS TIMBERS TO CARRY TYPICAL KINDS OF MILITARY TRAFFIC UPON BAYS OF DIFFERENT SPANS.

By LIEUT. S. M. COLLINS, R.E. (T.), M.A., BARRISTER-AT-LAW.

THE Graphic Chart which is issued with this number (see *Plate*) is an attempt to obviate the necessity of calculation in respect of the road-bearer members in field bridges and similar structures of timber. It is complementary of some graphs contributed to the R.E. *Professional Papers* by Capt. C. E. P. Sankey, R.E., some of which it incorporates. It is now possible, given the traffic, the span of bay, the quality of timber, and the scantling, to determine instantly the number of baulks necessary to carry the load safely. This would be, perhaps, the most usual question asked of the chart when a work is being designed, but any one of the factors can, of course, be found if the others are known. Thus an estimate of the capabilities of already-existing structures can be made, or verified, from the diagrams. The method of use is explained in the text on the chart itself. All the scales, with the exception of that of the span of bay, are, it will be seen, logarithmic. The position of certain of the commoner kinds of timber is, for readier reference, indicated specifically on the scale of Modulus of Rupture at the approximate values usually assigned to them; but subdivisions of the line at regular intervals are also shown, to admit of the interpolation of the breaking strength of any sort of timber or other material within the limits of M_r adopted. Similarly the M_f for loads other than the troops and vehicles specified, stationary as well as moving, can be estimated on the vertical scale. The types of military traffic selected for illustration are:—(i.). Troops in all march formations. (ii.). The heaviest carriages that accompany, severally, such units as are most commonly found acting alone, (the names of these are appended to those of the corresponding vehicles). (iii.). The heaviest guns used in the field and some representative heavy transport conveyances.

The chart as a whole will be found more forbidding in aspect than intricate in practice. It is contended that in a few seconds, accurate information can be obtained which would otherwise demand lengthy and irksome computation; consequently, several alternative combina-

Digitized by Google

tions of span, scantling and number of road-bearers can be readily compared. And by the inclusion of traffic chart and spar charts in one diagram to the same scale, the liability to error in transferring readings from one chart to another or of adjusting them to differing scales is avoided.

Opportunity is gladly taken of acknowledging Capt. Sankey's generous permission to make use of his work, without which the spar charts would have been but partially complete ; but it is right to add that he is not responsible for the accuracy of the matter, nor for the manner of its presentment.

Digitized by Google

HISTORICAL DOCUMENTS OF MAJOR-GENERAL SIR J. T. JONES, BART., K.C.B., R.E.

(Continued).

Memorandum by Sir H. Clinton on the "Movements of the 6th Division at the Battle of Salamanca."

When the attack was made by the 3rd, 4th and 5th Divisions, the 6th, which with the 7th were in the second line, supported it, in columns of Battalions with intervals for formation.

When the 6th Division had arrived abreast of the Ampila height its left was vigorously attacked by a body of cavalry which had been concealed by the height, and at the same moment that part of the first line in front of the centre of the 6th Division was repulsed and a Column of the enemy was advancing with rapidity; there was just time to form the two right Battalions (Queens and 36th) of the 6th Division the immediate advance of which in line, drove back the enemy who had already been checked by the 32nd Regt., halted in close column.

After the enemy had been driven from his first position, the troops halted, and the 6th Division subsequently received orders to attack a considerable body of the enemy who had formed upon a rocky ridge backed by wood about ¾ mile distant, the Fusilier* Brigade belonging to the 4th Division advanced with the 6th Division to this attack, being exposed during the whole advance to a very severe fire of Artillery and then of Musquetry, to which no return was made; the loss sustained by the 6th Division and Fusilier Brigade was necessarily severe, but the enemy was drawn from his position and the success was complete; darkness prevented the enemy from being followed, but the 9th Caçedores pursued for a short distance and took two pieces of cannon.

At the Battle of Orthes, and in pursuing the Enemy to Barcelona.

On the 25th February† the troops under Sir Rowland Hill, the 6th and Light Divisions were assembled on the high ground opposite to

° *Marginal Note.*—If any corps was intended to turn either flank of the enemy's second position the movement was not made in time, or not sufficiently near to be perceived by either of the contending parties. No troops advanced to the attack with the 6th Division save the one brigade of the 4th Division and Maj.-Genl. Clinton was obliged to detach the 9th Caçedores under Lt.-Col. Brown to cover his own right from the enemy's skirmishers.

† *Marginal Note.*—Sir Harry Clinton's report of the movements of the 6th Division at the Battle of Orthes, and to the 2nd of March inclusive, did not reach Lord Wellington at St. Sever until after he had made up his despatch for England.

Digitized by Google

Orthes, but from the want of artillery the passage of the Gave could not be effected. Early in the morning of the 26th the enemy made a second attempt to destroy the bridge, the work for which object he was able to proceed with under the cover afforded by the suburb on the left of the Gave, and by a Tower on the extremity of the Bridge. In the course of this morning two fords were discovered above the town, below it there are none above the bridge of Bereux which had been destroyed.

Not receiving any intelligence of Marshal Beresford, who was to pass the Gave near Peyrehorade, Lord Wellington resolved to attempt to force the passage at the two fords above Orthes, though at this time neither of the brigades of nine pounders had arrived. It was about two o'clock when Sir Rowland Hill, Maj.-Genl. Alten and I received orders to march, leaving one brigade of my Division opposite to the bridge of Orthes; at this moment Lord Wellington received information of Marshal Beresford having effected the passage of the Gave, and General Picton had also passed below Bereux. Upon the receipt of this intelligence the movement was stopped, and the sixth and eighth Divisions received orders to march by their left while the second, etc., remained opposite to Orthes.

I arrived at the ford at which the 3rd Division had crossed at half-past five, and, as there was now not time for completing the passage before dark, Lord Wellington desired me to cross the next morning at daylight.

(27th). The 6th Division began to cross the Gave before daylight by a bridge of boats which had been thrown over in the night, at eight o'clock the Light Division began to pass, and joined the fourth and seventh, forming the left Column. The third and sixth Divisions were formed in parallel columns on the great road leading to Orthes.

The attack having commenced on the enemy's right by the 4th and 7th Divisions, the 3rd and 6th were ordered to advance about 10 o'clock. As soon as the 3rd Division which was upon the left of the 6th formed for the attack, I sent two Battns. under Lt.-Col. Coglan to turn the left of the enemy, and directed him to cover the further advance of the 6th Division against any body of troops the enemy might still have in Orthes. The Highland Brigade supported by the Portuguese advanced against the left of the enemy's position, Maj.-Genl. Lambert's brigade remained as a reserve. While this was going on the enemy made an effort, and for a moment drove back a part of the 4th Division, but a part of the Light Division advancing in support of the 4th, order was restored. Our advanced position on the right enabled me to place our guns in a situation greatly to annoy the enemy by firing into one of his reserves formed in 3 solid Columns. He still however continued to occupy opposite to us some very strong ground, and, under cover of musquetry, the 21st Regt. of Hussars crossed a deep hollow and attempted to make a charge. Part of the Regt. of Infantry to my left, surprized at the sudden

Digitized by Google

appearance of the Cavalry gave way; the Cavalry were repulsed after sustaining a very heavy loss from the fire of the 42nd Regt. and the Portuguese Brigade. The 6th Division was ordered to advance on the right of the road by which the enemy had commenced his retreat. This was along a ridge the ground falling in deep vallies on each side so that it was not possible for troops moving upon the flanks to keep pace with those upon the road. The 42nd Regt. gained the road and drove the enemy very handsomely through the village of Sallespipe, which was the last point at which he attempted to maintain any order, and so far the two battalions of the 6th Division under *Lt.*-Col. Coglan kept up with him. Here a part of the 2nd Division which had advanced by the great road from Orthes came up and joined in the pursuit. The 6th Division encamped near Sault de Navailles.

On the 28th we followed the enemy by the St. Sever road as far as Gatas rivulet, behind which he was strongly posted, having his right on St. Sever. The difficulties which Sir Rd. Hill had met with, prevented his reaching beyond Condures, and the attack was postponed until the following day, but the enemy crossed the Adour in the night.

On the 1st of March the 6th Division forded the Adour and followed the body of the enemy which had retired by the Barcellonne road, and was ordered to encamp between La Grenade and Cozeres. It was necessary to dislodge the enemy from the village of Borderas where he had established a post of Infantry with 3 pieces of cannon. This was effected with the loss of only one man of the 9th Caçedores.

On the 2nd at ten o'clock, the 6th Division still leading, the Column received orders to march. The enemy with the Divisions of D'Erlon and D'Armagnac occupied Cozeres, having his right on the village of Samansans, which he also occupied, and his left on the Adour. I sent General Lambert with his Brigade to turn the enemy's right and attacked Cozeres with General Pack's Brigade, supported by the Portuguese. The defence was not obstinate; the enemy retired on Barcellonne with the loss of between 30 or 40 killed and wounded and of 30 prisoners: the 6th Division had 2 officers and 40 men killed and wounded. The enemy having continued his retreat to Barcellonne the 3rd and 6th Divisions cantoned in the neighbouring villages.

At the Battle of Toulouse.

In the night of the 9th April the 6th Division received orders to march at 3 on the following morning to Lameergrat, where it joined the 4th Division. At 6 Lord Wellington arrived and gave us orders for the attack of the Enemy's position to the eastward of Toulouse. The 4th and 6th Divisions were to cross the Ess rivulet at the bridge of the Croix d'Orade, and as soon as they should have passed, to form 3 columns of a Brigade each, ascend the left bank of the Ess, and attack the Right of the enemy on the height of Montanotan, while the Spanish Division which had arrived on the great road near Croix

Digitized by Google

d'Orade should attack the left. The enemy occupied the village of Mt. Blanc through which the 4th and 6th Divisions necessarily must pass, but was presently dislodged by the advance of the 4th Division. During this flank movement the Columns were exposed to a severe cannonade, but the loss was inconsiderable. As soon as the rear of the 6th Division had cleared the enclosures of the village of Mont Blanc, it was menaced by a body of the enemy's cavalry which had descended the height. By this time too the Spaniards had been repulsed in their attack and were in flight, so that the enemy was able to reinforce, by a considerable body of Infantry, the point of his position, menaced by the march of the 4th and 6th Divisions. When opposite to the post they were ordered to attack, these Divisions halted, formed 3 lines and instantly began the attack. No sooner did the lines begin to move than the enemy's cavalry advanced upon the right flank of the 6th Division. To meet this I ordered the 79th Regt. to form Column at quarter distance on its inward flank. As the Cavalry approached it halted and formed square, in which shape a few rounds of musquetry induced the retreat of the Cavalry. The assault was steep, the height however was carried without a check though not without a severe loss to Maj.-Genl. Lambert's Brigade which was in the 1st line. The works on this part of the position not being in a defensible state were immediately abandoned, and as soon as I had gained the height, I advanced my left in order to carry on the attack of the works to the right where the enemy still held their redoubts; but the Artillery attached to the 6th Division having been detained by Major Beresford to cannonade the enemy's works from the village of Mont Blanc, we were constrained to remain for a considerable time on the defensive, during which the troops were partially exposed to the fire of several pieces of cannon from the enemy's works and the musquetry from a building in the nearest of them. As soon as two of our guns were able to open, the attack went on, Genl. Pack's Brigade supported by the Portuguese under Colonel Douglas drove the enemy from two redoubts, and afterwards maintained themselves in the unfinished works though the enemy made a powerful effort to recover that situated nearest to Toulouse and within reach of its guns. It was now again necessary to wait the further advance of the guns to prosecute the attack of the last remaining work in the enemy's possession. In this the Spaniards who had been collected after their first repulse were ordered and ready to co-operate, but the enemy having withdrawn his artillery, on the approach of the troops abandoned his works and they were taken possession of without further contest.

Digitized by Google

A LADY'S EXPERIENCES IN THE GREAT SIEGE OF GIBRALTAR (1779–83).

BEING THE DIARY FROM 1ST JUNE, 1779, TO 13TH JUNE, 1781, OF MRS. GREEN, THE WIFE OF LIEUT.-COLONEL GREEN, CHIEF ENGINEER OF GIBRALTAR (AFTERWARDS LIEUT.-GENERAL SIR WILLIAM GREEN, BART., CHIEF ENGINEER OF GREAT BRITAIN, 1786—1802).

(*Continued*).

NOTE.—From 1st January, 1780, until 15th January, 1781, there are two versions of the Journal, both in Mrs. Green's handwriting, but not identical. Frequently they are word for word the same, but sometimes one and sometimes the other has additions, omissions, or slight variations of language. Perhaps both were prepared from a rough original, such as the pocket book referred to in the entry following October 14th, 1799, or the one in two volumes (commencing on June 1st, 1779) may be the original, while the other (in one volume, commencing January 1st, 1780) may be the transcript referred to on February 2nd, 1780. The following is therefore a compilation from these two MSS. :—

1780.

Saturday. January the First. 1780. Easterly wind. Cold Morning. The Gov^r did not receive any Compliments in Form. He was as Usual upon the Grand Parade. We had only 8 Friends at dinner by Way of keeping up an Old Custom; the Times were too bad to allow any family to entertain; not only that but I was greatly indisposed and totally out of Spirits. The two Spainish Frigates went from Algezira. A Vessel in the course of last Night went to Cork. Several Persons call'd as Usual this forenoon; but not near so many as on former Occasions, indeed most people now began to look rather Unhappy at our Uncomfortable Situation. The Troops are in good Health and Spirits, and have been so during the whole Blockade. 1st January, 1780.

Sun^d 2. Easterly Wind. A Dull Cold Morning. We call this with good Reason the *Coolest* New Year that was ever experienced in Gibraltar. Find myself not quite so lame or ill as I was yesterday.

Mond^y 3. Easterly wind. Began raining just at Guard Mounting. The Enemy Seem Busily employ'd in covering themselves from the Wet. Their whole Camp seems under Water. We heard they are Sickly. Admiral Barcelo remains quiet over at Algezira with some Xebeques.

Digitized by Google

4th January, 1780.

Tues^{d} *4th.* Westerly wind. Tolerable looking Morning. Col and Mr Holloway dined at Capt Loyd's. Find myself a little better.

Wed^{y} *5th.* Easterly wind. Col dined at the Convent, not Mr Holloway. The Enemy the same way employ'd. Many Tents taken down and very large Hutts erected. No firing now. A General Court Martial ordered for to Morrow to Try a Soldier of the 58th for Theft. Two Deserters came In from the Wolona Guards Infantry.

Thursd 6th. Easterly wind. Cold Day. The man who was Try'd yesterday is Sentenced to be Hang'd. No firing today.

Fry^{d} *7th.* Easterly wind. Had company to Day—all Gentlemen. The man is to Suffer on Monday next. He is and has been an old offender. The Troops are a little inclin'd to Break out at this Season.

Sat 8th. Westerly Wind. Very Dull Morning. It began to Rain in the forenoon; Continued to do So all Day. At Noon came into the Mole a Vessel from the East brought to by the Guns at Europa—a Neapolitan loaded with Barley—said to be intended for Spain; it is supposed the Gov^{r} will detain the Barley for this Garrison; it is looked upon as a very great Blessing at this time, as it will help the poor Inhabitants and the Soldiers Families who now begin to Want.

Sun^{d} *9th.* Westerly wind. Clear Morning, but soon began to Rain; and at Guard Mounting it was Violent. Continued bad the whole Day. The Man of 58th would not go to Church; or even allow our Clergyman to go to him!

Mon^{d} *10th.* Westerly wind. It left off raining in the course of the Night; and it was a clear fine Morning. The Man went out at South Port at 11 oclock, the Usual Ceremonys being observed. The Party was Commanded by Lt Col Cochrane of the 58th Regt. The man appeared perfectly Stupid and had refused to have any Clergyman till at the very hour of his Suffering. He then allowed of the Prayers that our Clergyman offer'd to read for him; but said he was a Quaker, had deserved Death on Many former occasions he said,—an Irishman. This Day at Noon 5 Ships of the Line went through to the East, supposed to be part of D'Estaing's Fleet from Cadiz. The Ship which seemed to belong to the Commodore appeared to be Under Jury Masts. This Day turn'd out pretty fair. The Enemy appear Busy at their New Raised Batterys upon the Sea Coast, of which they now have nearly completed 3. They now seem to shew as if they intended to act upon the Offensive as well as Defensive. Barcelo's Ship is Closer into the shore than it has already been, and there are people who say He is Unloading part of his Stores and some of his Guns. However it is so Much the Stile to say every thing that Sounds like *Information* that I never depend on anything that I hear except form our Corps, who have good *Reasons* for all they Say.

Digitized by Google

Tues[d] 11. Westerly wind. Fine Day but Cold. About 3 oclock 11th January, 1780.
1 afternoon the Enemy Fired 4 Shott towards the Garrison from 'ort St Philip, supposed to get the Range. One Shott fell into the ardens, another into the Governor's Meadow, and one into the undation, the other not known. There was a Funeral Party going ut at the time, and as the Burying Ground is very near to where the hot fell it greatly alarmed Them. They only Staid to put the Corpse hastily into the ground and the Clergyman &c hastened back, since which no Soldier or Inhabitants are to go out to Landport to be Bury'd. A place is to be appointed out at Southport, near to the Jews Burying place.* The Working Partys and the Mules were all order'd In directly. Captain Sowerby was upon the Batterys and Fired from Williss. We were Engaged to pass this Evening at Capt Evelegh's. I own I was half afraid. A large party. We passed a very cheerful Evening. One of their youngest children appeared not very Well. All Remaining very quiet. A very fine clear Night.

Wed[y] 12. Westerly wind; fine Morning. At half past 8 the Enemy Fired 2 Shott; one a twenty four pounder; the other Grape Shott, which Grazed the Battery at Water Port. The other (viz., the Grape Shott) fell between Bay Side and the Glacis. At half past 10 they Fired 3 Shott from Fort St Philip, one of which Grazed a Centry Box and went into the Spur Guard at Landport. It was supposed that this was meant for the Flagg Staff as there was a great Many of our Artillery officers there. They also hurt a Mule who was in a Working Cart. The Colonel was looking over the Ramp at Landport when this happened; and one of the twenty four pounders fell within 3 feet of him! The third Shott came into the Town and fell upon the Roof of an Inhabitants House in a Back Lane in a Line with the Spainish Church—(there was not any Persons living in the House, they having Quitted it and gone into Spain upon the first of the Troubles). A Woman who keeps a Milliners Shop happened to be going by at the same time; had her Leg struck by some part of the Splinters of the Roof or by some of the Shell Work out of the front of the house. She was thrown down and insisted upon it both at that time and since that it was the Ball that hitt her Leg. However that was impossible as it must have broke her Leg. She was more alarm'd than any real hurt. It put Us all into a sort of Bustle and the same kind of Fears took hold of the Jews as did upon the 12th of September. Some of the Shopkeepers had taken away their Goods upon that Sunday's Firing, but as they found all had remained so long quiet they had about a Month agoe begun to bring them back to their Shops! So They now began to hurry them away

* Drinkwater says "A part of the Red Sands behind the Princess of Wales's Lines was appropriated to that purpose." The "Lady Augusta's Battery" is a part of those Lines; so that this is probably the origin of the Sand Pits Cemetery.

Digitized by Google

12th January, 1780. for the Second Time. Indeed it now look'd to be more Necessary than at the first, for it was now most reasonable to expect the Enemy would come on. I had a further supply of Family Matters sent to the Mount, but as the Weather was cold I did not Stir myself. I sent the child out this Day.

Thurs^{d} 13. Westerly wind; it began to Rain very early, and continued to do so all Day. Everything quiet from the Enemy, but the Garrison in a Bustle. Much talk at this time about the Provisions,—as it certainly must be nearly Reduced. Thundered in Even.

Fry^{d} 14*th*. Westerly wind, raining at Guard Mounting. Colonel Ross of the 39th came out to the Parade this morning for the first time since He was so very ill, which was in the Month of October. He called upon us after Breakfast. Had a Meeting of Colonels and Field officers at his quarters in forenoon, relating to the Provisions for the Troops. Their allowance is to be in part Lower'd. It is from the Beef and Pork they have been obliged to Reduce this. We hope that by this Regulation there is remaining in the office enough for 3 Months. The Troops all Seem Satisfied and are in good Health and Spirits. Some few Friends in the Evening. This Evening a Man of the Artillery, Capt Loyd's Company, was Drownded at the New Mole. He was in Liquor and fell off a Plank. I was taken ill again in the course of the Evening, a Cold Shivering and a pain in my Left Arm.

Sat^{y} 15*th*. Westerly wind; Raining all Morning. Find myself exceedingly ill; pains all over. Doctor Baynes call'd in the forenoon and greatly alarmed me, by telling Us of the Small Pox being again Broke out, upon a Child of Captn Evelegh of the Corps of Engineers this is a fine Boy, about Six Years old. He did not seem very Well when We sup'd there on last Tuesday Evening. They have two Younger to have this Disorder. It hurt me to hear of this and also the whole Garrison as it is not a thing to be wished, just at such a Juncture as this, when we can only Manage People in Health. We were in hopes that by the great care that was taken in Nov^{br} last and by every appearance at the close of the year that it was all over,—however it could not be so, as Undoubtedly this little Boy had taken it by having been at play with the Spainish and Jew Children after they had returned home. We hear that the Gov^{r} will not allow of any Innocculation. Whilst I was thinking of the Unpleasant Prospect that Presented itself and supposing everything that is bad would follow,—behold at 2 oclock we heard of a most Interesting piece of News! A Vessel appear'd coming round Caberitta point, which proved to be an English Store Ship! Oh! What a Joyful Sight! The Sloop of War was sent out, likewise the Cutters and Arm'd boats. They brought her into the New Mole—with more than half the Garrison looking at Her! We find it to be a Brig, in the Ordnance Service call'd the *Sophia*, bound for Minorca, with 3 Artillery officers for

Digitized by Google

hat place. As Soon as the Admiral's Boats went on Board, we heard three cheers, which was answered on board the *Admiral* &c., &c. We now hope for Good news, which, thank God we had. She brings information that she is one of a Grand Fleet coming to this Garrison, consisting of Three Admirals and 21 Sail of the Line and that one of the young Princes is on board the *Prince George*, Admiral Digby, that they all left Portsmouth upon Christmass Day, were separated five Days after they had left Eng^d, in a Gale of wind. This news you may be well assured was truely Welcome. We find there is a Post Chariott on board this Brig for Us, but that is a Mere Trifle in comparison to any one word of good News that is brought to this Garrison. The pleasing hopes of a happy relief to this place is too great to express. I strive all I can to get well and to partake of this happiness, but I grew so bad with my Left Arm in the Evening that I was almost Distracted. It Rain'd hard in the Evening. A man of the 58th Deserted this Morning. We are in Earnest expectations, laying for the next Day, in hopes some of the Convoy may be coming In, as the Master of this Vessel thinks they must be near at hand. 15th January, 1780.

Sun^d 16. Westerly wind. Blowing and raining. We grow Uneasy about the Fleet. These 3 officers of Artillery are very Young Men, and They do not exactly agree in their Accounts, and for the most part say they do not know whether all, or only a part of the Convoy is for this place, or even who they all are. All this makes Us full of eager hopes and fears. I am a little Easier. A Spainish Deserter came In this forenoon, of the Wolona Guards. Nothing appeared all Day from the West! At last, about 7 in the Evening we heard some Signal Guns from our Admiral. They were made to a Vessel which was going up too high in the Bay. She was order'd into the New Mole, and proved to be a Ship belonging to Merchant Anderson, Loaded with Flour, and had left the Convoy 5 days agoe. She brings an account (this rather a Confused one) of an Engagement. Oh! how we all long'd for Morning to know more. It was blowing very hard. We had a Number of different Reports brought In between 7 oclock and Bed time. We hardly know what to think.

Mond^y 17. Westerly wind, very windy and raining hard. Find myself still very bad, and my anxiety great. The Troops were this Day put upon a Shorter allowance, as to Beef and Pork. They still appear Satisfied. Capt Evelegh's Son very ill. At Noon it Blew a perfect Storm. Every one is Uneasy about the Fleet. No News all Day! Let any one Judge of our Anxiety,—but that is not possible, except by those who have experienced the like Circumstances. No Firing on either Side at this time. Barcelo still nearer the land.

Tues^d 18. Westerly wind, a more Moderate Morning. About 10 oclock a Joyful Sight presented! A Prize brought In, taken by

Digitized by Google

18th January, 1780. Some of our Convoy, a fine Rich Ship Loaded with Oil, Tobac Soap, and Bale Goods. At Noon a much larger and more Valuab one came In, a Prize to one of our Men of War. She was brough In by a Lieut of the Man of War who had taken Her, is Loade with Brandy and Masts. Now We are certain of our Good News There has been an Engagement indeed! The Particulars are no well known, any how We now expect more Ships. This is th Queen's Birthday, but no Notice is taken, any otherwise than b the Royal Standard being up. It began to Rain hard and to Thund in the Evening. Several large Ships in Sight, and in the Close of th Day an English Frigate came In, which proved to be the *Apoll* Capt Pownoll. He was greatly surprized when going on board th *Panther* to find that Admiral Duff was not on board at such Juncture as this! but He was inform'd the Admiral was a *Quie Man!*

*Wed*y 19. Westerly wind; at Day Break our Governor ordered 21 Guns to be Fired into Fort Barbara, and the Royal Standar was up. At Guard Mounting the Admiral also hoisted the Roya Standard and Fired 21 Guns, the Drums all Beating, the Men of Wa giving 3 Cheers, and the Parole was "*Victory*." The *Edgar*, 7 Guns, Capt Eliott, came In this Morning. She brings great an Glorious news; our Fleet in their passage first fell in with a Fleet o Carraco Ships, took 7 of them, Estimated at £400,000! sent ther all except one to Eng^{d}. Then upon Sunday the 16th they fell with part of the Spainish Fleet. They had a very hot Engagemen off Cape St Vincent, a kind of running fight. The *Bedford* ran 8 miles during the Engagement! It Ended by our taking 7 of the Line of Battle, and one 80 Gun was Blown up; every Soul on boa Lost except one poor Wretch who Died in a few Days. We too their Admiral, Don Juan Langara, in an 80 Gun Ship, the *Phœn* We hear the whole Fleet are expected In here. They consist of Sail of the Line, besides Frigates. The whole place is now i of Joyful Confusion. I find myself Something better; and Ev Strive to appear more so than I am in reality. We do not he as yet of any Material hurt to our fleet. The Spainish Admiral now coming In, on board his own Ship; a good deal wounded. H wished not to be removed from his Ship, and gave his Word to t Admirals that his Men should bring his Ship In Here, or any P they chose. He was Trusted, and is now coming In. He has lost m than 200 men. It was to the *Edgar*, Capt Eliott, and the *Defe* Capt Cranston, that the *Phœnix* struck. It Rained and Thunde all this Evening. Several Men of War coming In. This Even Don Juan Langara was brought on Shore and taken in a Sedan C to a House prepared for his and his officers Reception. He allowed to bring all his *Suite* and Baggage. He is not Mort Wounded, but his first Captain is. We also hear that a very

Digitized by Google

Young Man in our Service has had his Leg Shott off, Lieut Forrest, on board the *Ajax*, and a Lieut of Marines Kill'd. No others as yet that We hear of. Lt Forrest has a Brother; a Lieut in the 58th Regt in Gibraltar. 19th January, 1780.

*Thurs*d 20. Westerly wind. Early in the Morning The *Prince George*, 90 Guns, Admiral Digby came In, on board of which was His Royal Highness Prince William Henry. The Royal Standard up in the Garrison for the third Day. The Prince came on shore at Noon, had no particular Honors paid him. He went to the Convent; from thence He was attended by the Govr the other Generals, and the Chief Engineer up the Hill as far as Williss. This is the King of Spain's Birth Day, and it has been said it is the Enemy's Intention to Fire upon this Day. Barcelo's ships are all Dress't, and He fir'd three times as is their Custom. He is Certainly Drawn Nearer the Shore; and We See there is a Work going on over at Algezira. Some of his Guns are likewise taken out. More of our Fleet coming In, and several officers calling. The Highland Regt also are arrived. The Colonel was Taken not Very Well this Evening and fear He is going to be indisposed. We hear there is a great quaintity of Provisions and Stores come to the Garrison. All now is Joy and Bustle.

*Fry*d 21. Westerly wind. More of the Convoy coming In. The Prince on Shore again, Walking about. He dined at the Convent. This Day at 3 oclock 6 officers belonging to a Spainish Man of War who was wrecked upon the Coast of Spain were allowed to pass into Spain, in order to Settle about Exchange of Prisoners. They went out with the Town Major and a Drum. No Firing from us Now. Several of our old acquaintances calling. Lt Trigge of the *Bedford* here in the Evens. At 12 this Night we were all alarm'd by a Firing from the Enemy from the Forts near the Sea,—Point Negro, Fort St Philip, &c, Algezira. We naturally concluded it was now their Intention to begin, and I declare I did expect to see the Shells in the Town any moment; it was now that I really was alarmed. It was at 4 of our Men of War which had come in, and by the Current was hurried up near to the Lines; it alarm'd the Enemy more than Us, as no doubt they expected it was an attempt to set Fire to their camp. They fired an amazing Number of Balls and one Shell. It Wounded the Rigging of the *Terrible* which was one of the 4 ships and hurt a few Sailors, also one Spainish Sailor who was on board the *Terrible*. They all got back to the New Mole. It was a very fine Moonlight Night. The appearance of the Enemy's Firing was a Grand, tho' alarming Sight, and I own I suspected it was their full Intention to throw Some shells into the Town. Thank God they did not; and we all went quietly into our Beds at 3 oclock. There was no Confusion or any Bustle in the Garrison; the Picquets were out, as usual at these times,—and always are upon any particular firing.

Digitized by Google

22nd January, 1780. *Satur^d* 22. Westerly Wind; a Cold Raw Day. Many of the Convoy not as yet come In. The Colonel was not better for having gone out in the Damp last Night, indeed he grew very ill in the Evening. We got 2 English Sheep from our old Friend Admiral Digby. This Morning more of the Small Pox appear'd, at an Inhabitant's house. Capt Evelegh's 3 children are all Lay'd down in the Disorder. He is obliged to leave his House for the time, not being able to stay from his Respective Duties at such a Busy Period as this. No Persons are allowed to go to his or any Inhabitants Houses, except the Doctors. The General will not allow of Innoculation as yet, but Says He will as soon as it gets amongst the Troops. This Day we get a Box of Things from on board one of the ordnance Ships which had been on board Six Months, consisting of *Family* Matters for myself and child. Also We Receive 3 sheep and a cask of Butter from Mr Veale at Portsmouth. The Colonel grows much Worse in the Evens. The *Nottingham* Store Ship, with Colonel Picton, Lt Col Craig, and Several others arrived this Day,—all hurry. Get some oranges as a Present from Capt Pownoll who has been over to Barbary. We hear that Admiral Sir George Rodney is over there. The *Childers* Sloop is cruizing about the Bay.

Sun 23. A Dull Morning. The Col: not worse. Began to rain after Breakfast. A good deal of company of the new comers &c this Day at Dinner. This evening after orders,* relating to the Commanding Officers, to give In a Return of the Troops fit for Service, by which it is supposed that the Highland Regt is to be Left here. At 10 this Night the Colonel grew exceedingly bad. It was a very Stormy Night. The *Childers* Sloop of War that went out two days ago returned from Barbary with expresses from Sir G. Rodney who is over at Tetuan but will not Venture In till all the Convoy is Safe. We hear that the *Royal George* Admiral Sir J. Ross is behind the Hill. This Day I experienced both pleasure and pain; Joy for Good news; and Vexation at the Colonel's Indisposition,—So very Unlucky.

Mon^d 24. Westerly wind. The Col very ill, did not get up till after dinner, obliged to send excuse to Admiral Digby for not being able to dine with the Prince today. Great hurry and much Confusion in the Garrison, Unloading the Stores and Provisions; every place towards the South is to be made use of for the King. Get 4 Sheep from on board the *Nottingham*.

Tues^d 25. The Colonel still very indifferent. This Morning Admiral Sir George Rodney arrived in the Bay. In the forenoon 5 of the Wolona Guards made an attempt to Desert from the Line. They were followed close by a Party of Horse as far as the Garden and some even as far as our late Burying Ground. There they killed or

* *i.e.* "After-Orders" were published.

Digitized by Google

Man and Mortally Wounded an other who died just as our People got him into the Bayside Guard. The other 3 got safe into the Garrison. 25th January, 1780. We fired both Grape and Round Shot at them from Williss, but did no other Execution than killing one Horse and hurting an other. In the Course of this afternoon most of the Convoy got In and also Sir John L. Ross. No sort of Supply of Fresh Stock as yet from Barbary, by which means the Garrison was as badly off as before; only with this difference,—We were all in Spirits and had frequent presents of Mutton &c from our old acquaintances in the Fleet. This forenoon I received a Small Box from on board the *Nottingham*, Under Care of Lt Col Craig, Containing letters, papers, Books, &c,—our last dates 18th Dec^br^. I was obliged to write Cards of excuse from the Colonel to Several Gentlemen who were to have dined here as to Morrow, he being too ill to See Company. Raining all this Evening. Have been writing this Evening to my Friends in England, and have begun to Transcribe from my long Journal a few Articles which I intend for my Son; as I understand the Convoy may go Unexpectedly. Also I have begun some letters to go by the *Childers* Sloop which is to go the very first Instant the wind will allow.

*Wed^y^* 26. Westerly wind, fine Morning; the Colonel something better. At 8 oclock Capt Evelegh came to ask for two Mules to bring Sir G. Rodney from the Landing place, as he was expected to come on Shore, and the Gov^r^ had a Litter ready for him. The Prince on Shore today, but the Colonel could not attend upon him. Several Persons call'd. All in great hurry Still.

Thurs 27. Easterly wind. The Colonel still very Indifferent. Doctor Baynes thought it better to Bleed him. All Busy in the Fleet. Flaggs of Truce all day going about in the Bay, and Parleys from the Lines. We sent away the Sick and Wounded Prisoners. I finished one long letter to my Sister which Sir John Ross enclosed in his Pacquet. The Sloop expected to go to Night.

Fry 28. Easterly wind; Raining and a bad Morning. The Sloop not yet gone. Several Promotions in the Navy. Capt Macbride is going home in the *Childers* Sloop with Dispatches. He has changed from his former ship the *Bienfaisant* to the Spainish Admiral's, the *Phœnix*. A Lt is to command in Capt Macbride's absence. Capt Conway has got the *Bienfaisant*, and Capt Peacock who had the *Childers*, has got one of the Large Spainish Prizes, called the *Diligenta*, and a Lt of the Admiral's (Sir G. Rodney) goes home in the Sloop, taking Capt Macbride as Express. This Day turn'd out exceedingly bad. Blowing and Raining very hard. The Colonel not Worse. We had two Hampers of Sugar brought on Shore this Day, which was on board the *Nottingham*. We Understand they were for us, being in the Bill of Lading, tho' the Directions were off. They are totally destroyed, and not one pound will ever be used in the house; they are wet and have also been

Digitized by Google

28th January, 1780. destroyed by all sort of Vermin. It is believed it was all owing to Carelessness. This is a Loss, but a greater disappointment than even the Value at such a time as this. This Day more Flaggs of Truce and Parleys. All Firing has ceased now. At 8 at Night it Blew exceedingly hard. The Sloop has attempted to get out but We are doubtful, as it Seems coming to the West. All this time Don Barcelo seems busily employ'd in getting out his Guns, and it is beyond a doubt that there is a Battery on the Shore near to Algezira. The Report is that the Camp is exceedingly out of Spirits, and Don J. Langara has declared to our Gov^r and Admirals that the French has deceived Them !

Sat 29. Westerly wind, Raining and Blowing a perfect Storm. The Sloop was obliged to return in the Course of the Night, after being forc'd to throw over 3 Guns. Lt Howe* of the 12th was the only officer of the Garrison allowed to go home ; and he was sent for from England upon account of his having got a Company in a new raised Regt. This forenoon a Spainish Frigate came from the West. most certainly a Stranger to what was in the Bay. She was chased by one of our Line of Battle and a Frigate, but Unluckily They were too Late. She got too close into the Shore. Our 2 Ships of War keep up a Smart Firing upon her, particularly the *Edgar* (the Line of Battle Ship). She (the *Edgar*) got under their Guns and all the Battys and Pigeons Island† &c, all fir'd. The Frigate seem'd greatly hurt by our firing ; and was Tow'd into Algezira by all the Boats from Barcelo in the Evening. A very bad evening. The Fleet for Minorca getting ready. Sir William Draper is going to his Lieut Government. It is Settled for the Highland Regt to remain here and They are getting all ready at the Bomb proofs under the King's Bastion for their Reception, and at the Picquet Yard under the Grand Battery.

Sund 30. Westerly wind, raining exceeding hard all Night and this Morning. N.B. It is just now the very worst Weather we have had this Season, which is Unlucky as it in Some degree retards the publick business ; at least it makes it Uncomfortable to every Body particularly those who are employ'd in Unloading Stores and Provisions The Minorca Convoy sailed this Evening. The Colonel getting better every hour. Intended going out today but was persuaded to stay at home ; it turning out so wet. I finished a letter to my Son and gave it to Captain Macbride who expects to sail as soon as ever it is in the smallest degree favorable.

Mond 31. Westerly wind. Indifferent Morning. Col at Gun Mounting. The whole Morning but very Dull ; and the afternoon Still Worse. The Col sent cards for company on Friday next

* Or How.

† Another name of *Green Island*, off Algeciras.

Digitized by Google

Flaggs of Truce all Day. 3 men of the Wolona Guards came In, which makes *22* in all. They are to go on board our Fleet. The two first which came In (viz., 11 Nov^br^) have remained in the Gov^rs^ Gardens at Work. 31st January, 1780.

February 1st. Tues^d^. Westerly wind and a very Dull Morning. Col at G. Mounting. It Thundered all Morning, poured with Rain all Day. The *Childers* got away last Night, but we fear is drove behind the Rock. Sir J. Ross call'd here. This Night turn'd out the worst We have as yet had,—Thunder, Rain, and Wind,—the Ships all driving about and Several Signal Guns firing. Every body is anxious for our friends in the Bay, and all long for Morning.

Wed 2nd. Westerly wind, bad weather still. Col better, dined with Col Ross and passed the Evening.* I am as busy as I can spare the time in Transcribing a Small Journal for my Son, but am frequently broke In upon, by the Number of Visitors that are constantly calling; Not only that but the Daily Necessity I have in attending to all sorts of Family business, makes it almost impossible to go on in the Writing Way. I shall at last get into a Total disregard to Method, Stile, or Sense I fear; for as I wish to write to the *Very Moment*, so it can never be the Effect of a Studied writer.

Thurs 3. Westerly wind, a very Wet bad Morning. The Colonel better and able to go to Parade; and out upon the Hill. The Prince did not come on Shore this Day, it turn'd out too bad. Very Busy this Day in Settling the Manner of Exchange of Prisoners. Barcelo is quite close In Shore; and it is now observed that There is a Boom making over at Algezira against Landing, such as ours at Water Port. We do suppose He is half afraid of our Men of War. There is also a Battery completed, near to Algezira.

Fry 4. Westerly wind; Raining Still. The Col kept waiting to See if the Prince would come, tho' it appear'd too bad; however at *12* He came, and the Colonel attended him upon the mountain. Flaggs of Truce in the Bay. We had a very Large Company, of the Navy chiefly, at Dinner. The Colonel returned very late to Dinner, exceedingly wet from his walk. He brings Word that the Admirals and the Prince would Breakfast at Mount Pleasant to Morrow. I accordingly order'd everything Proper; and mean to go myself if the Day will admit. A great deal of Company this Evening. Lt Forrest of the *Ajax*, who as I mentioned before was Unfortunately Wounded, and who had been brought on Shore Some Days to his Brother's Quarters, of the 58th Regt Died this evening, very much Regretted. He had got Promotion, Sir G. Rodney having just appointed him Master and Commander, in the hopes He would Recover. He was

* Here ends the entry for this date in the single-volume version of the Diary, which renders it probable that it is the transcript referred to in the following sentences.

Digitized by Google

4th February, 1780. just 20 years old; a very fine Young Man; Universally Esteemed. The *Childers* Sloop got through yesterday.*

Sat 5. Westerly wind; a clear and fine looking Morning, and luckily continued So all Day. It was the only tolerably pleasant one that has been since the Fleet came In. I went in my chair to the Mount. The Prince &c came on Shore about 9, and walked first to the Cave &c, the Colonel with him; and Ended the Walk at the Mount where everything was in proper Readiness. He was Delighted with the Gardens and Walks; it was favorable, so pleasant a Day. I was as much pleased with Him. He is a very fine Youth and must be liked in any Situation. His Questions were proper; they all wore the face of being the Result of a proper Curiosity. After the walk was over the Colonel went on board the *Prince George* to Dinner, and I return'd to Town that Evening, very well Satisfied with the Day.

Sun^{d} 6. Cold Indifferent Morning. The Col: busy in writing till Dinner at General Boyd's. This Day Capt Robinson in the *Shrewsbury* arrived to the Satisfaction of Many; that Ship and the *Dublin* being mis'd. The last is obliged to Remain at Lisbon to be made fit to go to Sea. The *Shrewsbury* has taken a tolerable prize; and Sold Her at Lisbon. Neither She nor the *Dublin* were in the Engagement upon the 16th Jan, having been Separated in a Gale of Wind before that Day. Sir J. Ross here today.

Mond 7. Westerly wind. Busy writing for the Fleet as it is expected They will soon leave Us. We have a very large Party at dinner this Day, Sir J. Ross and many of our Navy Acquaintances; and also of the Highland Regt. In the forenoon the Colonel went on board the *Sandwich*, and gave an invitation to Sir G. Rodney to go to the Mount as He has expressed a wish to Lay a few Nights on Shore. Sir J. Ross has pressed me exceedingly to go on board the *Royal George* and to take a Rough Dinner with him on Wednesday; also to take my own Party, all which I have promised to do, tho' at the Same time, think it will not be possible; as it is very likely the Wind may be Easterly; in which case I Understand it is likely that Division may have orders for Sailing. I should very well like to see so fine a Ship, particularly as Sir John is so pleasing and so cheerful an old Man. A very large Party at Night. N.B. Colonel Ross quite in Spirits now his Friend is here. We all wish, for his own sake, He could go home with the Admiral.

Tues 8. Westerly wind. The Colonel out all the Morning with the Prince and Admiral Digby &c. The Fleet in a hurry. At noon I heard that some part of the Fleet was to sail directly. I employ'd most of the forenoon in getting Journal and all *Writings* ready tho' as I observed before, it is no Easy Matter to gain the time; as I

* "This Day" in the two-volume version.

Digitized by Google

s quite impossible to be *Denied*, our Situation will not allow it ; our House is Constantly full. I find it rather too much for my Strength or Spirits but can not help it. The young gentlemen very Busy in he Plan way. 8th February, 1780.

Wed 9. Easterly wind, fine morning, but think I shall not be able o go on board ship to Day, as Some of the Ships seem getting Ready. At 11 a Signal gun was Fired from Sir G. Rodney for Admiral Ross and his Division to go to Sea directly. I received a Message of excuse from Sir John, and they were off before one oclock. This Day Don Juan Langara received an express from Madrid, informing him of the King having appointed him a Rear Admiral, with the Rank of Lieut General. N.B. He was only before Brigadiére de Marina. We send off some more Spainish officers and Sailors in a Flagg of Truce. N.B. We have not had any in return yet. Mr Raleigh, the Govrs Secry is appointed Commissary for Exchange of Prisoners, and goes at all times in the Flag of Truce Vessels. Many of the Spainish Sailors are mortally Wounded.

Thurs 10. Easterly wind. It is now Settled that the Spainish Admiral is to go back into Spain in consequence of letters which has passed between our Admiral in Chief and the Court of Spain.

I have omitted to mention that Admiral Duff went on board the *Royal George* on Saturday last with an Intention not to come on Shore any more. He goes home as Passenger with Sir J. Ross. There was no Ceremony Used at his going. He call'd upon a few Persons only. We were of the Number. He seem'd a good deal discomposed and Disconcerted.

Fry 11. Easterly wind. All Bustle in the Garrison. Unloading ships and getting ready for the Fleet. The Colonel every moment employ'd. Many Parleys every Day, and letters from the Commander in Chief in the Camp, Don Martin Alvares, and our Governor, and between Marquès Gonzales de Castejon, Secretario de Estado y del Despacho de Marina, and Admiral Sir George Rodney. Don J. Langara dined this Day on board Sir G. Rodney, as did the Prince &c. Don J. Langara is to go away in two Days. N.B. He had dined at the Convent before and was exceedingly politely Received. He was highly pleased with the Young Prince ; and made him a Number of Genteel Speeches. He spoke in French, which His R.H. speaks very well.

Saturd 12. Easterly wind. The Prince took leave of Me and was again at the Mount. They talk of sailing either to Night or in the Morning. All Bustle, all Confusion. My letters going by different Hands. The Colonel Dines on board Sir G. Rodney, finds the Store Ships will not be able to go, it being impossible to get Ready. This Day the Spainish Admiral went away. Great Civility shown him. He went in a Vis-a-Vis of the Genls was drove quite close to the Gate at the Spainish Lines. Several officers attended him to our out

Digitized by Google

12th February, 1780. Guards, but no further; only as Usual the Town Major and one Drum as with a Parley. Great Compliments at parting, and a very great Cavalcade meet the Spainish Admiral with Led Horses &c at the Lines. Langara went away fully convinc'd that He had met with the utmost politeness He Ever could have wish'd for and much more than He could have expected. He Seemed a good sort of man; was Very highly displeased with the French. This Day Several Vessels came In, some from Cork and from other places; also one was brought In Loaded with Barley, intended for Cadiz. We have not as yet had any Live Stock from Barbary; nor do I hear of any Mode Settled about getting any! Several Town Market Boats are over there, and the *Apollo* Frigate went over to Barbary this Evening.

Sund 13. Easterly wind. The Signal made for Sailing. The Colonel went on Board both Admirals with planns &c, &c, and took Leave of the Prince. A most fortunate Event took place this Morning, viz., the Men of War that went up to Minorca with the Convoy (this Day fortnight) return'd Just as our Fleet was getting under sail! Nothing could have happened more favorably. The chief part of the Fleet got out this Evening with a very fine Wind. Great hurry just now all over the Garrison. All those that could were getting off as fast as possible. All the Family of the Powndles going &c &c.

Mond 14. Easterly wind. The whole Fleet left Gibraltar this Day. It will not be amiss if I make a few remarks on some fortunate events that has attended this Fleet from the Day they left England, which was upon Christmass Day 1779. Some Days after they left Portsmouth it was not known whether the whole or a part was coming to this place. However after they had obey'd the Signal from Sir G. Rodney and had received his orders they proceeded on their passage here. They fell In with the Valuable Fleet of Carracs Ships, took them to the amount of £400,000! Then they met with part of the Spainish Fleet, took 7 of their Line of Battle. The rest of that Fleet under command of Don Luis de Cordova had gone only Six Days before into Cadiz, not suspecting any such Fleet as ours, which indeed shews how greatly the Spainish Court had been deceived by the French; for it is very certain had they keep a look out it must have been known. Our Fleet had the Satisfaction to get all the Convoy for this Garrison Safe; and relieved us to the utmost of our wishes; from thence sent off to Minorca all that Garrison stood in Need of, viz., Money and cloathing for Troops. The Wind carried all that Convoy up, and was so much favor'd in returning that it was only barely possible to form such a wish with any degree of success! Not only that, but what made it still more fortunate, they came back upon the very Day the Admiral was getting out of this Harbour it was indeed the very thing We all most wished for, tho' hardly

Digitized by Google

uld have expected. They sailed with a fine Wind, which lasted as ng as to carry Them where they wished, and by the Information a Vessel from the West who came In upon the 20th We learn that e Fleet was met with in so favorable a Latitude that it gives all anner of prospect of a quick passage home, If so it may not be at ll impossible for the whole of these Circumstances to have happened n the course of Ten Weeks ! to Say Nothing of what may fall out in heir passage home, or indeed of other matters which I have not aken notice of in form, all adding to the peculiar favor of Provi-ence,—and Surely never was a more Remarkable Period in History; of a Succesful Passage and a fortunate Supply to a Blockaded Garrison. 14th February, 1780.

We now hear by the arrival of some English officers and other risoners belonging to our Fleet who are sent In from Cadiz that hen the Spainiards which were in Brest Harbour heard of our Grand leet and of our having taken Don Juan Langara, they directly left rest and with 20 Sail of Line sailed for Gibraltar, in hopes to meet ur Fleet or to Force this Harbour. A Violent Storm attacked them nd has in a great degree drove them to destructiom ; they are getting s fast as they can into Cadiz, but for the most part Unfitt for service, Those that are not as yet arrived may very likely meet with our Fleet home. If they do they will Stand a bad chance. The report now is that the Spainiards are so totaly displeased with their French Friends and so provoked at what has happened to themselves that it is pretty Certain they mean to Try all their Efforts to gain this place, for they have repeatedly told our English officers, they only want and wish for Gibraltar ! "Give up that to us, they say, and all will be Well."

From the 14th of Feb, the Day on which our Fleet left us, Nothing ery particular Happened till the 25th, except the whole attention of he Garrison to get into safe places all the Stores and provisions. he Boom which Barcelo made over at Algezira has been taken up er since our Admiral and Fleet Left Gibraltar. They have hang'd everal Soldiers in their Camp, but that has not hindered more of eir Wolona Guards to come to Us.

Fry 25. Westerly wind. A Vessel arrived from Farro, Loaded th Wine &c for this place, but the most Valuable part was a umber of Letters of different dates to many persons in the Garrison had the Satisfaction of Receiving one letter of 12th Nov from Mrs een, and one of same date from Mrs Nicolls and one of 12th Dec m her. It afforded great Satisfaction. We had a large Company Dinner, Genl and Ladies, the Davies, Gledstanes &c. The eather fair but cold. Barcelo seems busy. A Vessel arrived to ar with wine and other articles frome Minorca. The Small Pox is gnning to be very fatal to the Children. All Means are tried to ain Leave to Innoculate but as yet to no purpose.

Digitized by Google

26th February, 1780. *Saturd* 26. Easterly wind. We all begin to get letters wrote h hopes the Store Ships will be soon going. I try all Means to get Charlotte inoculated but cannot obtain leave.

Sund 27. Easterly wind, very fine morning, and continued so all Day. I did not stir out being not well. 3 Line of Battle Ships and other Ships are gone over to Barcelo this morning. A Neapolitan Ship came into the Bay, was brought to by a Gun from Kings Bastion. She sent off a Boat and said she was last from Minorca, Loaded with Oil and Honey, bound to London. She anchored near the Old Mole and afterwards sent off a Boat to Fort St Philip. This should make Us doubt if she is a Friend. However in the Night she went from her Station, and was seen at Algezira the next Morning!

Mond 28. Easterly wind. Colonel engaged all forenoon at Col Ross, and the rest of the Colonels, relating to the Circumstances of the Rank between Lt Col Trigg, Lt Col Craig and Lt Col Mackenzie. N.B. It is to be referred to the Commander in Chief in England.

Tuesd 29. Easterly wind, very fine Day. Nothing very particular all this Day. Several People in Evening. A great many Northern Lights in air. No News of the Prisoners that were expected. Yesterday the Troops had for the first time Salt Fish delivered to them instead of Meat and some Rice and Peas, not any Butter; which occasioned great discontent; as it seems hard to oblige them to take the fish in place of Meat and not to give them a little Butter with it. We hear it is to be changed. N.B. This Evening they all Received a Small Allowance of Butter, but they are dissatisfied.

March 1*st*. *Wed*^{y}. Westerly Wind, and very fine Day. It was in Orders this Day that Capt Lt Witham of the Royal Artillery is to be Aid de Camp in the room of Capt Patterson of the Same Corps.

Thurs 2. Westerly wind, fine Day. This Morning 2 Sailors came over from Barcelo's Fleet in a little Boat. They belong'd to the place, and were taken some Weeks agoe from out of a Towns Vessel which Used to cruize about. They have been kept on board one of the Spainish Men of War. They bring Word that there is 3 Battalions of the Spainish Troops gone from the Camp, which indeed we have known, by finding Many of their Tents struck. It is also said They are gone to Strengthen some part belonging to the Spainiards.

Fry 3*rd*. Westerly wind, fine soft Day. We had a large Company at dinner and more in Evening,—Gen Boyd, Phipps, &c, and Fancourt in evening,—all very well. No change in any publick Business.

Saturd 4*th*. Easterly wind. A good deal of wind. The Col: Rod out, The Day continued fine. Find I have got a great cold and some other complaints. Mr Holloway dined at the Convent. We were quite alone in Evening.

Sun 5. Easterly wind and a Dull looking Morning. At Noon blew exceedingly hard and continued so for more than an hour.

Digitized by Google

5th March, 1780.

ast it began to Rain which abatted the wind. N.B. The New Moon was about this time. We had a good many Gentlemen at Upper. The Small Pox raging very much and very fatal.

Mond 6. Easterly wind. Hear that an Inhabitant, Mr Brooks, is going away this Night on board a Swedish Vessel. I send one letter to Mrs Green and one to Mrs Nicolls. Not very well this evening and out of Spirits.

Tuesd 7. Easterly wind. The Ship did not go last Night. The Col: writes this Day to Mrs Boddington and to Fisher, also to Genl Skinner. Genl Boyd sent us a hind Qr of Wild Boar. The Col and Mr Holloway Sup't out at Capt Loyd. Our letters went under care of Mr Brooks who went on board this even.

Wed 8. Easterly wind. Find the Ship is gone last Night. This Day we find that the Enemy are sending away Many Articles from the Camp, and loading Vessels at the Orange Grove. Likewise it was observed that the officers Baggage was taken away as fast as they could send: Trunks and all Sorts of Camp Equipage. We had a very large Party in the Evening, Mrs Booth and Family, &c, &c, 16 in all.

Thurs 9. Easterly wind, fine Day. Nothing more than a Parley from the Enemy today. Went out to Capt Phipps at dinner; the Col Rode out all forenoon. Hear that Commander Elliott had sent out to the Enemy to know why those English Prisoners were not sent In, and to request the Don J. Langara would be return'd into Gibraltar, unless we had our own People sent.

Fry 10. Easterly wind, fine Day. Dull and Cold. The Col walked out. At Home in the evening, quite alone. A Parley from the Enemy this Day.

Satard 11. Easterly wind, fine at first but turned Dull and Cold in forenoon. The Colonel dined at Convent. At home in evening, only ourselves. A Parley from the Enemy to Day.

Sund 12. Easterly wind; fine in the forenoon, but Dull and Cold at Night. I walked out before Dinner and called upon Several Persons. Hear that the English Prisoners are coming In from Spain. There are two Flaggs of Truce gone from Us, and three Row Galleys are coming from the Orange Grove to Us. The Windmill is moving from where Capt Evelegh first fix'd it. It is to go to Windmill Hill.

Mond 13. Easterly wind, fine clear Morning. The Prisoners came last Night and are going on board the Men of War this Day. Two men of the 72nd Regt Deserted from off the Hill last Night, and one of the same Regt went off 2 Days agoe. This Day the Provisions were first delivered out by the Month to each officer. Each Man's Share is as follows; I mean each officer's Ration. I shall set down by Way of Mem^m^ the Order that was given on this subject. N.B. There is some small difference between the officers and the private

Digitized by Google

13th March, 1780. men's Provisions. N.B. Upon the whole this order has not given satisfaction. The Fish, tho' very good is objected to; at least the being obliged to receive it for so long a time, particularly as it is supposed there is such a quaintity of Provisions in Store. This evening 2 of the Deserters of the 72nd taken, the other not known.

Plan for Victualing the Garrison for one Month; to Commence on Monday the 13th March. Officers of the Army and Civil department, to draw for a Month's Provisions at one time, and in one order. (Bread excepted, which will be Issued weekly) and if they leave any in the office it must be entire Rations, which will be accounted for every three Months.

It is conjectured this will be thought Disagreable, for as yet no Method has been found which Way those Provisions are to be paid for which may now Remain due to Individuals in the office. The whole of this department is now in the Hands of the Q.M. Genl.—New Lords, New Laws, the Agent Victu^er has nothing now to Do!

One Month's Single Ration for an Officer.—Beef 3 lbs; Pork 2 lbs; Fish 9 lbs; Pease 8 pints; Wheat 5 lbs; Rice 4 lbs; Oatmeal 6 pints; Butter 40 oz.

N.B. Colonel Green has Ten Rations.

One Month's Ration for a Soldier.—First and third week as follows:—Pork 1 lb; Fish 2½ lbs; Pease 2 pints; Rice 1 lb; Oatmeal 1½ lbs; Butter 5 oz; Wheat ½ lb; Raisons ¼ lb.

Second and fourth week as follows:—Beef 1½ lbs; Fish 2 lbs; Rice 1 lb; Wheat 1½ lbs; Oatmeal 1½ pints; Raisons ¼ lb; Butter 5 oz.

Each Hospital Per Week as follows:—Beef 2 lbs; Fish 2 lbs; Rice 1 lb; Flour 1 lb; Oatmeal 3 pints; Raisons 1½ lbs; Butter 5 oz.

N.B. All the above took place Mond 13th March 1780.

Tues 14. Easterly wind. Dull Morning. I went out to the Mount in the Post chaise for the first time,—took Charlotte. The Day did not turn out quite so fine as I wished. Hear there was a man of La Motte's deserted from Forbes last night. The Town Boat call'd the *Fly*, came over from Barbary, brings a few Fowls and Eggs also a packet of letters, none for Us—says there is an English Vessel now at Tangier from Eng^d, in 15 days from Portsmouth. In the afternoon there was firing from Europa at a Xebeque that was trying to Attack a Brig that was bringing In a small Prize. She proves to be an English privatter, call'd the *Maidstone*. She was In here and went away about three weeks agoe. Has brought In a little Boat and got safe to the New Mole. The *Enterprize* fired at the Xebeque but did not reach Her. It is this Day reported that there is a large Army of French intended to come into the Spainish Camp to attack this Garrison, and that they are Daily expected.

Digitized by Google

Wed 15. Easterly wind, a very Dull Morning. It rained very early. Find myself exceedingly indisposed, could not get up to breakfast. This Day a Court Martial sitting upon the two Deserters of 72nd: Colonel Picton 12th Regt, President, 4 Field officers, Captains. In the afternoon a Cutter came from the West; she came from Scilly, had fallen In with a Spainish Frigate of 36 Guns off Cadiz and had Received Some damage. N.B. The beginning of this Month Mr Raleigh Secy to the Gov^r was appointed Commissary for the Exchange of Prisoners. The hurry and Daily hopes and Expectations which now prevailed, particularly in Weak Minds, began to Affect me, and I grew exceedingly ill. My Head and Eyes very bad, hardly indeed am able to write this, and fear I am going to be very ill. It was the same with me some weeks ago, but as I only write for the Amusement of myself and if ever it so happen for my own family's Information in a few points,—so I am the less anxious about the Stile or Manner. No one in evening. 15th March, 1780.

Thursd 16. Easterly wind, tolerable Day. Find myself rather better but not in spirits. Nothing new this Day. Very little to be got in the Market this Day. The child and two of the Maids went to the Mt in afternoon. Fine Night. A Cutter came In from the West, call'd the *Alert*. She was bringing In a prize. She is a fine Privateer. She lost the prize. It was taken into Algezira.

Fry 17. Easterly wind, very fine Morning and continued so all day. Hear that the two Deserters were to be shott, the time not yet fix'd. Several Signals up at our Look out; from the East; and in the afternoon a Large Number of Vessels going through, supposed to be a Dutch Convoy. Find myself very much indisposed this Day with a Severe Cold; which has affected me for above a Month past.

Saturd 18*th*. Easterly wind, fine Day. Capt Loyd upon Batterys to Day. Fired in the Evening. I was not Well this Day or in Spirits, find the Smallest Vexation hurts my Health, and I feel pains in Consequence of it.

Sund 19. Easterly wind, fine Day. In the afternoon the Enemy fired a Feu-de-Joye in their Camp, as did likewise all the Men of War over at Algezira. The whole Line turned out and appeared a large Body. Various opinions formed. Both yesterday and to Day we fired more shott than for some Weeks past. The Gov^r has also given orders to the captains upon the Batterys to fire at the Patroles in the Night. Capt Shands upon the Batterys to Day. One of the two soldiers lately Try'd is Reprieved this afternoon. The other is to be Shot Tomorrow.

Mond 20. Easterly wind, a very fine Warm Morning. Hear that the Rejoicing in the Camp was on occasion of a Son Born to the Prince of Asturias, Son to the King of Spain. One of their officers told one of ours, when they met on a Parley that such an event was hourly expected and wish'd for. This is the first Son. We find by

Digitized by Google

20th March, 1780. the appearance of their Men Under Arms that there is still a larg Number of Troops in the Camp, and also a Battalion over at Algezira Notwithstanding it has been said They had sent away a great man Regts. This forenoon the Man of 72nd was shott. He had formerly belong'd to 58th and had married the Daughter of the Sergeant Major of that Regt who was sent for to the Gov^r of this Garris some years agoe by Sir Will^m How who had a great regard for th Sergeant Major. He made him an officer and he is now a Capt in Regt in America. This Soldier's Wife is in England. His Name Traverss. He seem'd to feel for his Wife and Her Father.

Tuesd 21. Easterly Wind, pleasant Day. We Kill'd a Small Co this forenoon for the Use of the Family, and sent away as present the following Pieces. The Cow weighed 400 lbs. A Sir Loin t General Boyd; a part of the Ribs to Colonel Godwin; a piece of the Loin to Roast and a small piece to Boil for Capt Phipps; a part o the forequarter and a little piece for Soup for Colonel Gledstanes; part of the Sir Loin to Doctor Baynes; a part of the Ribs for th Engineer Mess; a piece for Boiling for Mrs Skinner; a piece f Roasting for Mrs Booth; a piece for Roasting, Capt Evelegh; Round for Mrs Power; and a Shin or two for some Sick families the Head and Liver between Serjeant Grant and one of our Marrie Servants. N.B. We had been offer'd 25 Guineas for it and I daresa might have had £30, for Every Body was Selling as Dear as the thought proper, but I detested the imposing practice. This Co Turn'd out exceeding Good Meat and was very Acceptable at th Juncture. It was the 2nd of my Cows. I have now 2 Cows a a young Heifer left. This is the first Field Day this season. T Colonel went out at Landport this afternoon. He saw the Capt of Landport Guard, as he was Walking out, near the Meadow, w two Gentlemen that are Here on their way to Algiers, one of the Brother to Mr Wilks. The Col thought it wrong to go so far w strangers, particularly leaving the Guard. The Captn ought alwa to be at his Post.

Wed 22. Easterly wind, a Dull looking Morning. The Capt that was at Landport yesterday was put Under arrest this morn at Gun Fire; by order from the Gov^r for leaving his Guard yesterd and going as far as the Devil's Tower with those two Gentlemen. is Captn Duff of 58th.

Thursd 23. Easterly wind; a Dull Day. Had Company to D I write a long letter to My Sister and sent it by the Sloop Private the *Alert*. Find myself much indisposed.

Fry 24. Easterly wind. Dull Day. The Sloop sailed last Nig 2 Line of Battle Ships and 1 Frigate gone from Algezira. Capt D out of Arrest, no consequences having follow'd, except a Caut given to all captains at Landport Guard for the Future.

(*To be continued*).

Digitized by Google

TRANSCRIPT.

SUBMARINE CABLES FOR LONG-DISTANCE TELEPHONE CIRCUITS.

Extracts from a paper by MAJOR W. A. J. O'MEARA, C.M.G., LATE R.E., *and read before the* INSTITUTION OF ELECTRICAL ENGINEERS.—*Reproduced by the Courtesy of the* INSTITUTION.

(*Concluded*).

Messrs. A. W. Martin and J. G. Hill, of the Post Office Engineering Department, recently carried out a series of comparative speech tests on a number of cables of this type by the kind permission of the late Mr. C. E. Krarup, Engineer-in-Chief to the Danish Telegraph Service. The results obtained on one of these cables are shown graphically in ***Fig.*** 1.

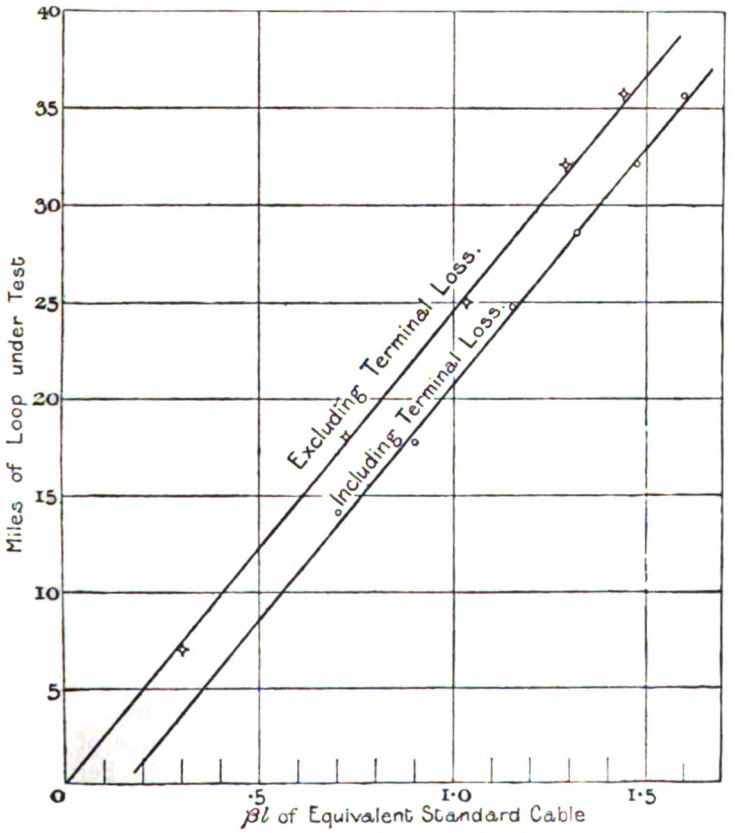


FIG. 1.—*Efficiency Tests of "Continuously" Loaded Cable.*

Length, 1·78 miles. Type, 4 quads + 12 pairs.
Copper, 2 m.m.². Iron, 1 layer 0·37 m.m. wire.
Loop resistance per mile, 27·64 ohms.
Wire-to-wire capacity per mile, 0·08 microfarad.
Inductance per mile, unknown.

Digitized by Google

The observed attenuation constants of another of the Danish cables is given in Table A, and for comparison therewith, the attenuation for the same cable as found by calculation, and the attenuations calculated for ideal cables with the same copper conductor are also shown (1) unloaded, and (2) loaded with inductance coils. The details for these calculations are tabulated in Appendix IX. The data given in Table B relate in a similar manner to a cable actually loaded with inductance coils, the attenuations when unloaded and when "continuously" loaded being calculated from the particulars in Appendix IXA.

TABLE A.

Based on actual "continuously" loaded cable.
Overall diameter of copper, 126 mils.

Loading.	Outer Diameter of Gutta Percha. Mils.	$\beta \frac{1}{\text{Knot}}$	
		Observed.	Calculated.
Three layers of 7·88 mils iron wire	355	0·0296	0·0197
Unloaded	355	—	0·0369
Coils of 100 millihenries every 1·075 knots . .	335	—	0·0148

TABLE B.

Based on actual "coil" loaded cable.
Overall diameter of copper, 106·2 mils.

Loading.	Outer Diameter of Gutta Percha. Mils.	$\beta \frac{1}{\text{Knot}}$	
		Observed.	Calculated.
Coils of 100 millihenries every knot	390	0·0166	0·0166
Unloaded	390	—	0·0520
Three layers of 7·88 mils iron wire	405	—	0·0230

A wide difference is seen to exist between the ascertained values for attenuation of "continuously" loaded conductors and those which theory seems to predict. The expressions for inductance and eddy-current loss take cognizance of the air-gaps necessarily present in the wire winding, but the eddies are considered as existing in each circular cross-section of the wire alone, thus assuming that no current flows from one wire of the winding to its neighbours. This is a possible source of discrepancy, but the errors so introduced are probably small. Perhaps a more important source of error lies in the somewhat indeterminate value of the permeability of the iron after it has been wound on the conductor. Change of permeability due to overstrain during the winding of the iron is known to occur, and this may be large. The disagreement between observed and calculated values of the attenuation of cable loaded in this manner requires, and is receiving, further investigation.

Digitized by Google

The development of telephonic communication by means of conductors in comparatively long lengths of subterranean cables during the past few years has afforded the Post Office Engineering Department a valuable opportunity for making a close study of telephonic transmission under various conditions. In this way very much useful information has been accumulated and considerable practical experience has been gained. Mr. H. R. Kempe has gone very carefully into the method of calculating the attenuation of telephone circuits and the cost aspect in regard to the design of gutta-percha cable. The results are valuable, and some of them will be found in Appendix X.

Our investigations clearly indicated that it was possible to obtain more appreciable improvements in long-distance telephone cables by employing loading coils than by resorting to the "continuous" loading of the conductors. Therefore when the matter of the provision of additional submarine cables between this country and France was referred to the Engineering Department, enquiries were at once made to ascertain whether it would be practicable to provide, lay, and maintain in a satisfactory manner, a submarine cable of the "coil" loaded type. It was known that a lead-covered cable provided with loading coils had been laid across Lake Constance from Friedrichshafen to Romanshorn; the several features of the problem involved in this case and the method adopted in actually laying the cable have been fully described.* The conditions under which this cable was laid, however, were entirely different from those requiring the consideration of the Post Office Engineering Department, and it will be recognized that, in view of the difficulties which would arise in the event of the lead sheathing being punctured, it would have been a costly and hazardous experiment to provide and lay a lead-covered cable across the English Channel.

Whilst our investigations were in progress an article appeared† which was somewhat disturbing. As will be seen from the extract given below‡ doubt was thrown on the possibility of improving transmission in gutta-percha-covered cables by means of the so-called Pupin coils, on account of the low effective insulation of gutta percha to currents of high frequency. In order to settle the point definitely, it was decided to carry out some experiments. The Department had a large stock of No. 7 gutta-percha-covered wire (weight of copper, 40 lbs. per mile; of gutta percha, 50 lbs. per mile; resistance, 44 ohms per loop mile; electrostatic capacity wire to wire, 0·13 microfarad per mile), and also a number of inductance coils (inductance, 83 millihenries; resistance, 13·4 ohms at 750 periods per second), which had been used originally for carrying out some experiments in connection with the improvement of transmission of speech in subterranean cables between Liverpool and Manchester. Calculations were made to ascertain the best disposition of the coils in this particular type of cable—although neither the coils nor the cable were really of the

* *Electrician*, Vol. 59, p. 217, 1907.

† *Elektrotechnische Zeitschrift*, Vol. 29, 1908, p. 588.

‡ "Es ist danach fraglich, ob man überhaupt Leitungen mit sehr geringer Dämpfung als Guttaperchakabel mit Pupinspulen bauen kann, wenn nicht die dielektrischen Eigenschaften der Guttapercha erheblich verbessert werden."

Digitized by Google

most suitable type—and it was found that in order to provide 55 millihenries per mile they should be inserted at intervals of 1½ miles. A large number of speech tests were made on loaded circuits formed by means of the No. 7 gutta-percha wire, by myself, Messrs. H. Hartnell, A. W. Martin, and other members of my staff. It was gratifying to find that the actual improvement in transmission was in complete agreement with the estimates based on the calculations that had been made. (By calculation the attenuation was 0·0436 per mile, and the observed result was 0·0419 per mile). We found that commercial speech was certainly practicable on 105 miles of this particular type of "coil" loaded gutta-percha wire, and our doubts as to the feasibility of the "non-uniform" loading for submarine cables of moderate length were set at rest. The question of providing a "non-uniform" loaded type of cable was therefore proceeded with.

In order to be absolutely on the safe side, however, when preparing the specifications for this new Anglo-French cable, it was decided that the general design of the new telephone cable in respect of the copper and the dielectric should be exactly similar to the type already in use, which it was known would provide telephonic transmission of a certain quality, and that the improvement desired could be obtained by the contractors either by means of "continuous" loading or "coil" loading, the Department simply stipulating in the specification that the attenuation constant should not exceed a certain definite value. The main reason for this was that if it had been discovered after the cable had been laid that coils introduced effects not foreseen, the coils could easily have been cut out at a small cost and the Department would still have had a cable as good as the existing one. It is known that under certain conditions of design in the relation of the weight of gutta percha to that of copper per knot, an effect is created referred to colloquially as "drumminess." "Drumminess" is a property which causes speech to be muffled, and therefore renders it less distinct. In an unloaded circuit "drumminess" is generally unmistakable, when the ratio $\frac{K^*}{R}$ per mile is equal to 0·003. The greater this ratio the more marked is the "drumminess."

Selected firms were asked to tender for the additional cable to be provided by the British Administration. No tenders were received for the "continuous" type of loading, but three tenders were received for the "coil" type of loading.

The features of the device for loading in the accepted tender are as follows:—

The two double coils required for the four conductors of the cable, each coil being of slightly less than 6 ohms resistance and having an inductance of 0·10 henry at 750 periods per second, are inserted at intervals of 1 knot (1·153 miles), but the two coils nearest the ends of the cable are inserted at a distance of only half a knot from the terminal apparatus, as experiments have shown that in this arrangement reflection losses are considerably reduced. Each double coil consists of two windings on the

* K = microfarads, and R = ohms.

Digitized by Google

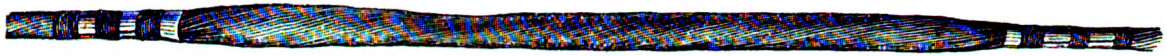
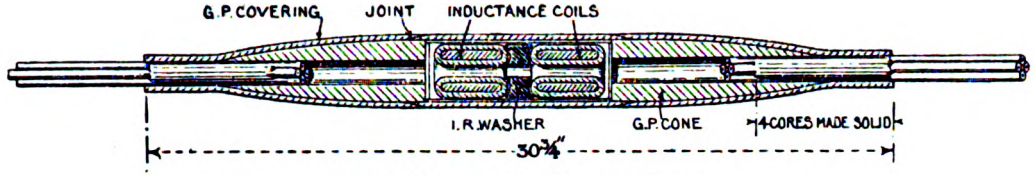
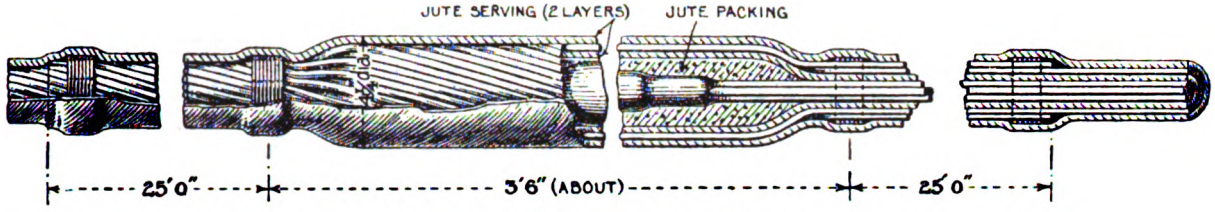


FIG. 2.—*Section of Cable containing Loading Coils, complete with Sheathing Wires.*



ARRANGEMENT OF COILS IN CABLE
(Scale about one-sixth)



METHOD OF SHEATHING OVER COILS
(Scale about one-sixth)

FIG. 3.—*Anglo-French Cable*, 1910.

Digitized by Google

same iron core, and one winding is connected in series with each conductor. By this means the gradual change in permeability in the iron core due to aging will not affect the balance in the two limbs of the telephone circuit. Each coil is protected with a sheet of metal foil in order to exclude all possibility of the silk covering of the wires of the coils absorbing moisture from the cylindrical envelope of gutta percha in which they are contained. The cores of the cable are connected to the envelope at its two ends by tapered solid gutta-percha joints. The diameter at the centre of the envelope is 3", and at the cores where the joints terminate 1". An annular rubber distance-piece is inserted between the two coils of a set to give greater flexibility. The total length of the joint in 30·75". As the diameter of the cable at the points where the coils are inserted is increased, a larger number of sheathing wires are required at those points than over the conductors alone. This difficulty is ingeniously overcome by starting a second layer of sheathing wires over the cores, about 27' from the centre of the coil envelope and gradually working them into a single layer with those over the bulge. Finally they are terminated as a second layer again over the cores at a distance of about 27' from the centre of the coil envelope. The method adopted in inserting the coils (Patent Specification No. 5,547 March, 1907) will perhaps be understood from the diagrams (*Fig.* 3).

It will be recognized that the mechanical problem in connection with this type of cable was more difficult to solve than the electrical problem, as it was necessary that the part of the cable containing the coils should be so designed that it could be paid over the sheaves of the cable-ship without any risk of damage to the coils themselves. However, I am glad to say that the manufacturers succeeded in solving this problem in a most satisfactory manner.

The cable was under the constant supervision of the Post Office Engineering Department during the period of its manufacture, and electrical tests were carried out from time to time. On January 18th, 1910, after the completion of the cable, measurements to determine its attenuation constant were made at the works of Messrs. Siemens Bros. & Co. at Woolwich. The conductors of the cable were joined up so as to provide a metallic circuit of 41·704 knots, and in order to get rid of terminal effects artificial cable was joined to the ends of the loaded cable thus:—

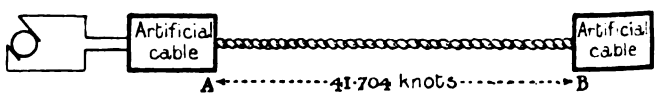


FIG. 4.

Current was supplied to this circuit by a generator giving 1·585 volts at a frequency of 750 alternations per second. Readings were taken on a thermo-galvanometer placed successively at A and B, and the attenuation constant was calculated by the formula $C_n = C_A \cdot e^{-\beta d}$.

With 10 miles of "standard" cable* (attenuation constant 0·1187 per

* Sir John Gavey, Inaugural Address, *Journal of the Institution of Electrical Engineers*, Vol. 36, p. 26, 1905.

Digitized by Google

knot) at each end of the circuit the current values at A were found to be 0·327 milliampere, and at B 0·172 milliampere, β therefore being 0·0154.

With 15 miles of "standard" cable at each end of the circuit the current values at A were found to be 0·212 milliampere; at B, 0·110 milliampere, from which we similarly obtain $\beta = 0{\cdot}0158$.

The volume of the speech transmitted over the loaded cable was also compared with that over an artificial "standard" cable, the electrical constants of which are known. The result of these tests indicated that the attenuation constant of the loaded cable was 0·0147.

If the electrical constants of the Anglo-French loaded cable are substituted in the formula—

$$\beta = \frac{R + \frac{S}{K} L}{2} \sqrt{\frac{K}{L}}$$

it will be seen that the attenuation constant obtained by the sent-and-received current test requires that the value to be assigned to $\frac{S}{K}$ in the above formula must be approximately 99, whereas the value of the attenuation constant indicated by a comparison with the artificial "standard" cable requires the value of $\frac{S}{K}$ to be 80. There is no doubt that leakage plays a very important part in the transmission of telephonic speech. Recently whilst in America, I found that one of the principal difficulties which had been encountered in that country in connection with the loading of long-distance aerial telephone circuits consisting of the larger gauges of wire was chiefly due to leakage. However, the difficulty has been largely overcome by the substitution of more efficient insulators for the glass ones which have hitherto been in general use in the United States.

We have long been aware of the great importance the ratio $\frac{S}{K}$ plays in the design of long-distance telephone circuits. In the case of gutta-percha cables there is certainly no noticeable leakage arising from faulty insulation as in the case of aerial wires; still the dielectric currents in such cases are appreciable, and practically represent an effective leakage. Dr. Breisig has informed me that he has carried out various tests on dielectrics and has confirmed the existence of such losses. For viscous dielectrics he finds the value of $\frac{S}{\omega K}$ (where S is the effective leakage, K capacity in farads, and ω is equal to $2 \pi n$) is independent of the value of K; in the case where $\omega = 5{,}000$ the value is found to be 0·018.

In dealing with the maintenance of "coil" loaded cables after they have been laid, the degree of importance to be attached to the uniform spacing of the coils has to be considered. In repairing cables, intermediate lengths have to be inserted at times, but fortunately if repairs of this character have to be effected in the "coil" loaded cable, no noticeable impairment in the quality of the speech will result if the coil spacing is disturbed to an extent not exceeding 5 per cent. on either side of the

Digitized by Google

best location from the theoretical point of view. It has been found that when physical conditions impose a variation of not more than 50 per cent. of the spacing for a single coil, no appreciable impairment in the quality of the speech will result provided the deficiency in loading is made up within the next ten loading sections. The frequency with which repairs have been carried out on the existing telephone cables, as shown in the chart Appendix XI., will convey some idea of importance of this matter.

The investigations that have been made left little doubt concerning the balance of advantages in favour of the "coil" loaded type of cable from the electrical standpoint, but as the expenditure involved was very great, and as it was felt that the main difficulty in connection with this type of cable would be in safely laying the cable at the bottom of the sea, it was considered that special precautions were necessary to ensure that the responsibility for any defects that might be disclosed after it had been laid, should be definitely traced to the responsible party. To afford the necessary protection to the Department, it seemed desirable to stipulate in the specification that the manufacturers of the cable should also undertake to lay it, and to hand it over *in situ*. This course was approved by the Postmaster-General, and the invitations to tender were issued on these lines. The conditions were accepted by Messrs. Siemens Bros. & Co., who were the successful tenderers.

The routes of the land lines serving the telephone cables to continental countries are shown in *Fig.* 5.

The cable has been under continuous observation since it was laid and a large number of tests have been carried out. Particulars of some of them are given in Appendix XII. It has fortunately been possible to obtain independent testimony on the question the increase in the range, and in the improvement in the quality of speech transmitted by means of the loaded cable as compared with a similar cable unloaded. Speech tests were made in July last by Messrs. W. R. Cooper, W. Duddell, F.R.S., W. Judd, and J. E. Kingsbury, and the results are interesting. The cable was looped at the French end (Cape Grisnez), and the English ends were connected to two telephone sets—one installed in the cable hut at Abbot's Cliff, and the other in the coastguard look-out shelter some 100′ distant. Graduated artificial cables were provided so that the listener at the cable-hut could insert various values of the "standard" cable into the circuit, until his own limit of satisfactory audibility was reached. It was possible to insert the "standard" cable values equally at the two ends of the cable (*i.e.*, so as to form a symmetrical circuit in relation to the submarine cable), or unequally, as desired. The results shown in the table on page 192 were obtained.

The mean gain by the use of the new cable is therefore 17 miles of "standard" cable for the standard of audibility accepted as commercial by the four observers named. When the cables were alone in circuit some of the observers noticed that in the case of the new cable there was a distinct improvement in the quality of the speech as compared with the old cable.

The employment of unloaded 800-lb. copper aerial conductors such as

Digitized by Google

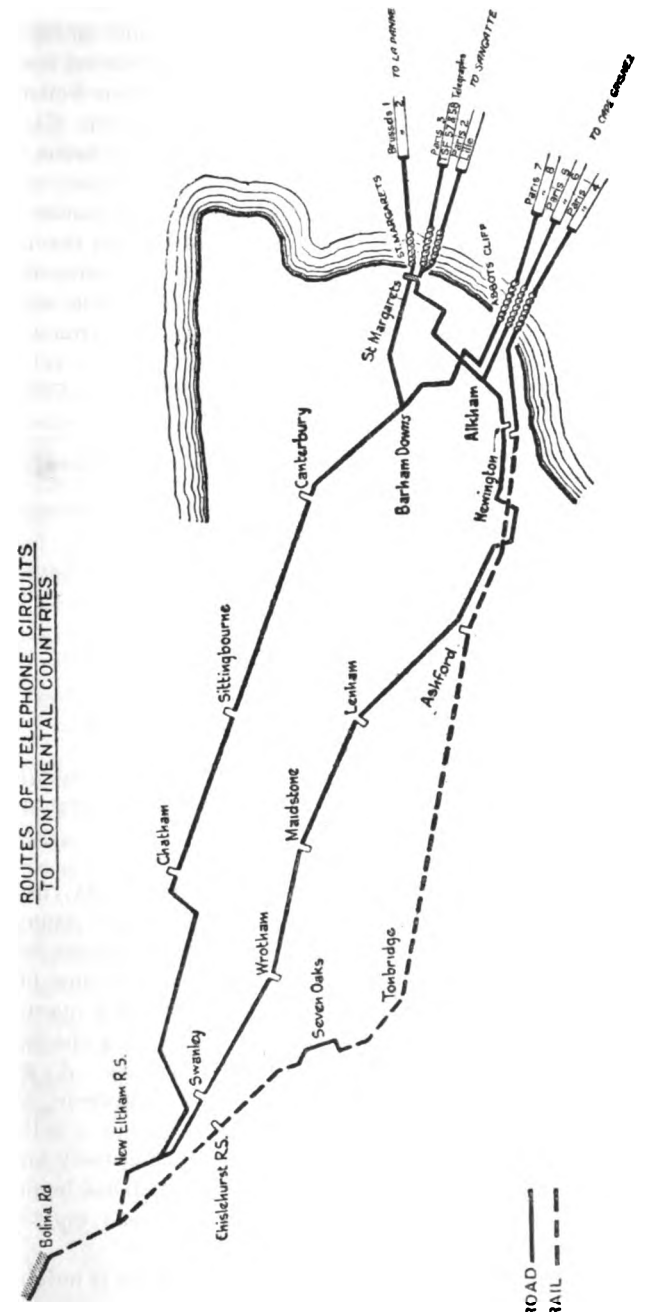


FIG. 5.

Digitized by Google

are in use for the most important long-distance trunk circuits in this country, will render it possible for very satisfactory conversations to take place from call-boxes between centres in England and on the Continent when the added distances from the ends of the cable do not exceed 1,700 miles: that is to say, with land-lines of this description well-maintained conversations between London and Astrakhan on the Caspian Sea would be possible. In his inaugural address to the institution,* Sir John Gavey included a table of equivalents of the various types of unloaded conductors. It may be assumed that in practice aerial conductors of the smaller gauges can be improved by loading twofold, and the conductors in cables threefold, so that it is not difficult to determine the centres between which the new Anglo-French telephone cable will provide communication, assuming that a particular type of conductor is employed to complete the circuit.

Observer Listening.	Old Cable.	New Cable.	Gain by New Cable
	Added Length of Standard Cable.	Added Length of Standard Cable.	
			Miles
W. R Cooper ..	24 miles symmetrical ...	48 miles symmetrical... ...	24
W. Duddell	24 miles symmetrical	40 miles symmetrical... ...	16
		‖50 miles symmetrical... ...	26
		‖55 miles at one end	21
W. Judd	26 miles symmetrical ...	40 miles symmetrical... ...	14
J. E. Kingsbury ..	26 miles symmetrical ...	40 miles symmetrical... ...	14

‖ As breakdown limits of hearing.

CONCLUSION.

Although great improvement in speech transmission has resulted from this latest type of cable, yet the new Anglo-French cable cannot by any means be regarded as the last word on submarine telephone cables. An attempt has been made in this paper to place on record some of the steps taken in developing the art of long-distance telephony, but many problems remain to be solved, and they do not appear to be of a character likely to yield a ready answer to those seeking their solution. As in the past, the co-operation of the mathematician, physicist, engineer, and manufacturer are still needed if an announcement is to be made in this theatre twenty years hence that the progress in the art of telephony has resulted in an increase of efficiency comparable with that which has been achieved during the past twenty years, and which it has been my pleasure to record here to-night.

The practical engineer recognizes fully how much he is indebted to the mathematical investigations of Heaviside, Pupin,† Perry,‡ Kennelly,§ and

* *Journal of the Institution of Electrical Engineers*, Vol. 36, p. 28, 1905.
† *Transactions of the American Institute of Electrical Engineers*, Vol. 16, p. 93, 1899.
‡ *Philosophical Magazine*, Vol. 36, p. 222, 1893.
§ *Transactions of the International Electrical Congress*, St. Louis, 1904, Vol. 1, p. 68.

Digitized by Google

others, in respect of the progress made in the past. There are to-day a number of earnest workers, both in this country and in foreign lands, who are sparing no efforts to render possible the transmission of speech from any one point of the habitable globe to any other.

I feel that the most important matter to which attention should be turned at the present time is that connected with the measures which should be adopted to ensure that the scientific and practical results obtained by the investigators in these widely separated centres shall be in such a form as to be easily comparable. A scientific spirit is abroad, and it has been agreed to abandon standards of commerce and to adopt those of the laboratory to record values affecting the efficiency of telephone circuits. So far so good. The problem, however, is one containing many complexities, and the final results, I think, must be measured from the point of view of the non-scientific user. It would appear, therefore, that it is not possible to deal with telephonic transmission from the consideration of the attenuation constant in its mathematical aspect alone, but it is necessary to take into consideration its practical aspect as affecting audition. In the early part of September, 1910, I had the privilege of taking part in experiments at Paris arranged by Dr. Breisig and M. Devaux-Charbonnel, which consisted in talking over actual telephone circuits, into which, in turn, artificial cables were introduced of three different types designed to reproduce conditions representing—

(*a*). Aerial wires.
(*b*). Unloaded cables.
(*c*). Loaded cables.

The talking circuits were so arranged that in each case the total attenuation was by mathematical calculation exactly the same. These experiments showed that the quality and volume in audition under the three different cases were by no means in agreement. Clearly then, for comparative purposes, it seems to be most desirable not only that the conditions with regard to the circuit arrangements, including terminal conditions, shall be identical, but that all those who are engaged in this important investigation should employ, in connection with their experiments for measuring audition, apparatus manufactured to the same specification and compared with an international standard. It is hoped that this result may have been attained as a consequence of the recent International Conference at Paris.

Digitized by Google

APPENDIX I.

MAP OF ENGLAND AND PART OF IRELAND SHOWING IMPORTANT SUBMARINE TELEPHONE CABLES IN BRITISH WATERS.

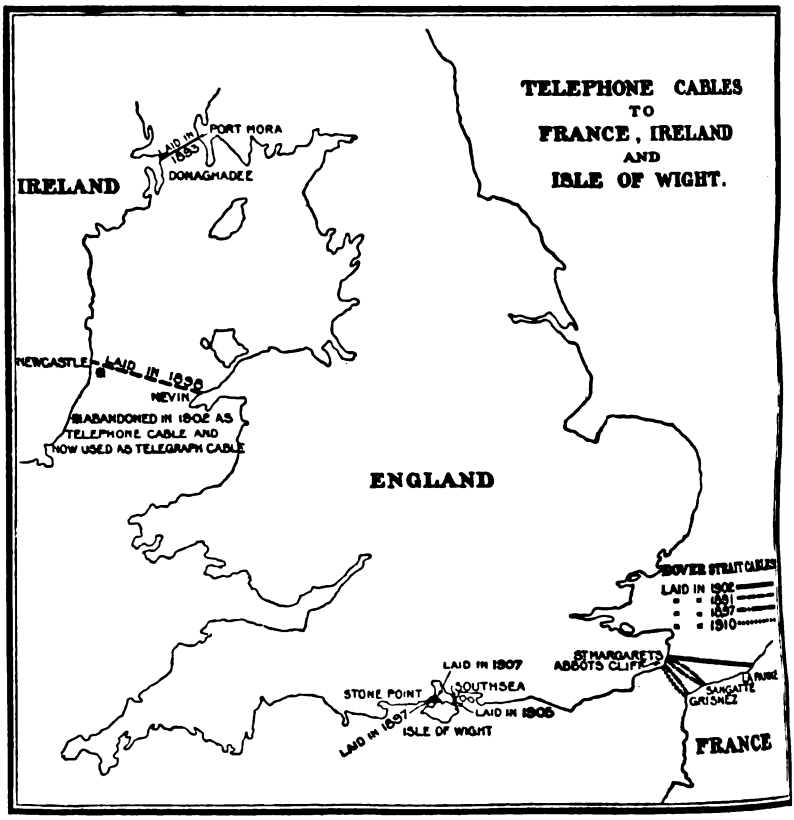


FIG. 6.

APPENDIX II.

SHORT DESCRIPTION OF THE FIRST ANGLO-FRENCH TELEPHONE CABLE.

(*Fig.* 8, Appendix VI.).

Opened to the Public April 1, 1891.

This was a 4-core cable differing but little from those in use at the time for telegraph purposes, except in the size of the cores. Each core consisted of a stranded copper conductor formed of 7 equal wires, having a total weight of 160 lbs. per knot, covered with 300 lbs. of gutta percha per knot. The extreme diameters of the copper strand (d) and of the gutta-percha covering (D) were 0·108 and 0·390″ respectively, giving a ratio $\frac{D}{d} = 3{\cdot}61$.

The measured resistance of the conductor at 75° F. was 7·453 ohms, and the measured electrostatic capacity 0·275 microfarad per knot. The sheathing consisted of 16 galvanized iron wires, each 0·280″ in diameter, put on with a lay of 18″, and the external diameter of the finished cable was about 2·2″.

Digitized by Google

APPENDIX III.

Description of the Air-Space Type of Submarine Telephone Cable.

In 1895 Messrs. Willoughby Smith and W. P. Granville took out a patent for a type of submarine cable core which was designed to combine the advantages of an "air-space" cable with low capacity, and of gutta-percha insulation with its well-known durability and impermeability to moisture. The method of building up the core will be obvious from Appendix VI., *Fig.* 10, which represents a section of the "air-space" cable laid in 1898 between Nevin, North Wales, and Newcastle, co. Wicklow. Each conductor consists of a central wire 50 mils in diameter surrounded by 10 wires each of 22 mils diameter. Two conductors were covered with gutta percha so as to form a crescent-shaped semi-circular segment, as shown in the *Fig.* Two such crescent-shaped strips were then "laid" together with a helical twist and doubly covered with gutta percha to a diameter of 0·580", forming a tubular core. The weight per knot of each of the four conductors was 138 lbs., and the total weight of gutta percha 552 lbs. per knot, that is, equal to the total weight of copper. The conductor resistance was 8·515 ohms per knot at 75° F., and the wire-to-wire capacity of diagonal pairs 0·1016 microfarad per knot. This capacity is about 19 per cent. less than the mutual capacity of two conductors in the ordinary Post Office type of submarine telephone cable. To prevent flooding of the whole cable in case of damage at any point the core was made solid at the joints.

APPENDIX IV.

Particulars of Three Submarine Cables connecting Nevin (Wales) and Newcastle (Ireland).

Cable.	Gutta Percha. Weight per Knot	Copper.		R. Standard Ohms. Per Knot	K. Wire to Earth. Per Knot.	I. Millihenries Per Knot.	Insulation at 75° F.	Total Length of Cable.
		Weight per Knot.	No. of Strands.					
	Lbs.	Lbs.			Microfarads.			Knots.
No. 1 telegraph cable	150	107	7/22	11·145	0·3333	2·195	Not less than 500 nor more than 1,000 megohms	56·078
No. 2 telegraph cable	150	107	7/22	11·145	0·3333	2·195	Ditto	60·630
Air-space type of submarine telephone cable	552*	138	10 wires 22 mils diameter stranded round a central wire 50 mils diameter	8·515	0·1974	2·06 diagonal wires 2·13 adjacent wires	988	57·123

* Total weight per knot for the four conductors.

Digitized by Google

APPENDIX V.

PARTICULARS OF TYPES OF SUBMARINE TELEPHONE CABLES PROPOSED FOR THE ANGLO-FRENCH SERVICE.

I. Hammered Segmental Conductors with Protuberances: Paper Insulation for Core.

(*Fig.* 9, Appendix VI.).

Weight of conductor, 900 lbs. per knot.
Each conductor $\frac{3}{16}$ S.W.G. to be covered longitudinally with one layer of paper 1·75" wide and 0·015" thick.
Whipped with 15 lea 2-ply yarn $1\frac{5}{8}$" lay.
The two conductors so insulated twisted together (about 3' lay) with protuberances adjacent and opposite, with nine papers each $\frac{5}{8}$" wide and 0·012" thick between them.
The pair to be lapped with three layers of paper 0·006" thick.
Six paper strings laid round $2\frac{1}{4}$" lay.
Double proof tape one coat, $1\frac{1}{4}$", $\frac{1}{4}$" lap.
Layer of vulcanized indiarubber, 0·047" thick.
Layer of double proof tape to a diameter of 1".
Thin coating of Chatterton's compound and gutta percha $\frac{1}{16}$" thick up to a diameter of $\frac{1}{4}$".
One layer of brass tape, $\frac{1}{2}$" lap.
Thin coating of Chatterton and covering of gutta percha 0·04" thick.
Coating of hemp, 25 lbs.
Waterproof separation from gutta-percha covering.
Weight of gutta percha, 1,400 lbs. per knot.
Sheathed with 18/0·280" Post Office wire.
Two coats 3-ply Post Office hemp.
Diameter overall, 2·22".
Weight per knot, 298 cwt.

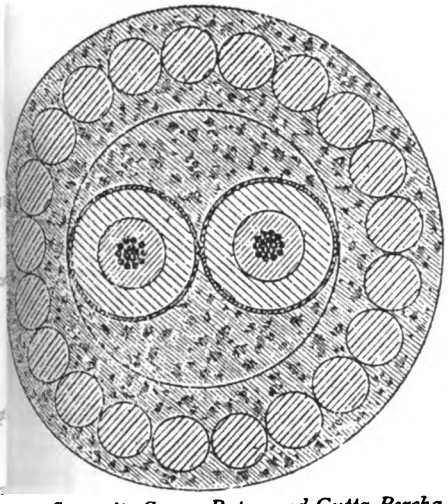
II. Composite Core Submarine Telephone Cable (Paper and Gutta Percha).

(*Fig.* 7, Appendix VI.).

Each conductor 500 lbs. per knot, 12-strand { 1 × 0·104". / 11 × 0·0385".
One longitudinal air-space paper.
Six spiral layers of paper (with gap).
One spiral layer of paper (without gap) to 0·43.
Gutta percha ($\frac{1}{8}$" thick) to 0·68" (572 lbs. per knot).
Actual capacity, 0·139 microfarad per knot (wire to earth).
Each core brass taped, 2 cores stranded, wormed, and served jute yarn.
Sheathed 21 × 0·280 galvanized steel, double jute served outside.

Digitized by Google

APPENDIX VI.



IG. 7.—*Composite Core. Paper and Gutta Percha.*
500 lbs. copper, 572 lbs. gutta percha.
(Full size).

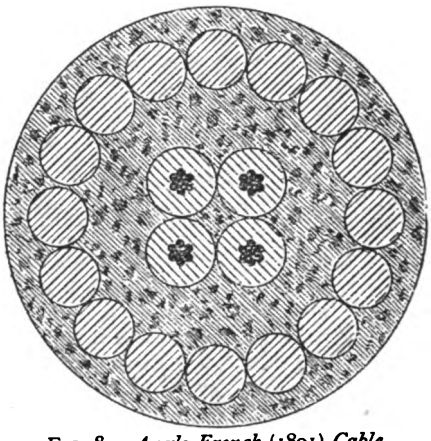


FIG. 8.—*Anglo-French* (1891) *Cable, Gutta Percha Core.*
160 lbs. copper, 300 lbs. gutta percha.
(Full size).

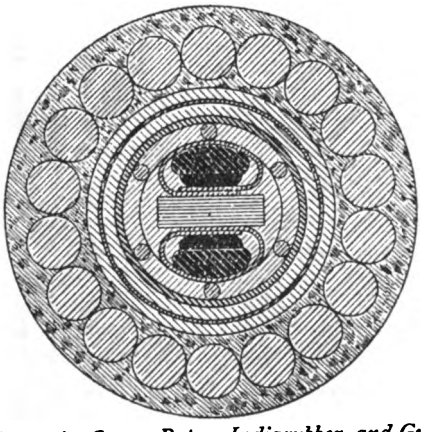


FIG. 9.—*Composite Core. Paper, Indiarubber, and Gutta Percha.*
900 lbs. copper, 280 lbs. indiarubber, 1,400 lbs. gutta percha. (Per knot).
(Full size).

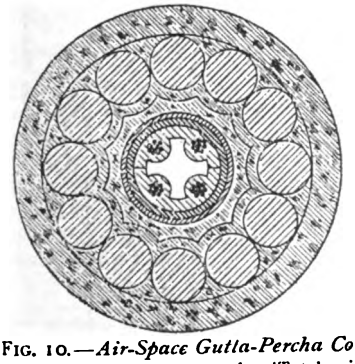


FIG. 10.—*Air-Space Gutta-Percha Core.*
552 lbs. copper, 552 lbs. gutta percha. (Total weights).
(Full size).

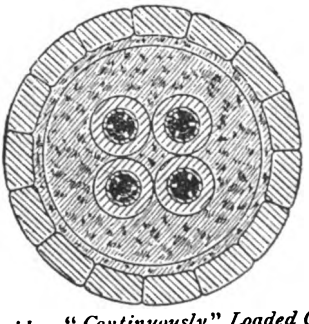


FIG. 11.—"*Continuously*" *Loaded Core. Gutta Percha.*
285 lbs. copper, 180 lbs. gutta percha.
(Full size).

SECTIONS OF SUBMARINE TELEPHONE CABLES THAT HAVE BEEN ADOPTED OR PROPOSED.

Digitized by Google

APPENDIX VII.

SOME FOREIGN "CONTINUOUSLY LOADED" SUBMARINE CABLES.*

	Cable.	Date of Laying.	Length in Knots.	Number of Conductors.	Copper Square Inch.	Wrapping of Iron Wire.	Insulation Thickness in Inches.	Lead Sheath.	Resistance in Ohms per Knot of Conductor.		Capacity Farads per Knot of Conductor.		Self-Induction Millihenries per Knot of Conductor.		Old Formula (Preece) $C'\gamma$.	β per Knot $n=900$.
									γ Continuous Current.	ω Alternating Current $n=(900)$.	C' Continuous Current.	C Alternating Current.	Prepared (Wrapped with Iron Wire).	Without Iron Wire.		
						Mils.			†	†	†	†	†	†		
A	Elsinore-Helsingborg ...	Nov., 1902	2·85	4	0·0054	7·88	Gutta percha 0·323	No	8·49	8·79	$0·324\times10^{-6}$	$0·3030\times10^{-6}$	4·92	1·100	$2·750\times10^{-6}$	0·0340
B	Fehmern-Laaland ...	Jan., 1903	10·38	4	0·0155	11·82	Impregnated paper	Yes	3·18	4·79	0·301 ,,	0·2660 ,,	4·65	0·850	1·075 ,,	0·0184
C	Greetsiel (Emden) Borkum	Spring, 1903	15·85	4	0·0054	11·82	Air-space paper	Yes	9·03	11·08	0·138 ,,	(0·1243) ,,	7·41	1·240	1·335 ,,	0·0225
D	Cuxhaven-Heligoland ..	Autumn, 1903	40 50	2+2/2	0·0186	11·82	Solid paper	Yes	2·53	3·38	0·170 ,,	(0·1490) ,,	3·98	0·595	0·427 ,,	0·0104
E	Seeland-Samsö-Jutland ...	July, 1904	8·93+11·02	4	0·0124	3×7·88	Gutta percha 0·355	No	3·98	4·18	0·500 ,,	0·4460 ,,	8·08	(0·900)	1·970 ,,	0·0156

The figures in brackets are, however, interpolated or approximately stated.

* See *Elektrotechnische Zeitschrift*, Vol. 29, p. 586, 1908, and also *Journal Télégraphique*, Vol. 29, p. 187, 1905.
† The figures refer to single-wire values.

Digitized by Google

"Continuously" Loaded Cables.

(Krarup Type).

The first "continuously" loaded cable having the copper conductor wrapped with a layer of 0·008" iron wire on Krarup's plan appears to have been that laid by the Danish Government, in November, 1902, between Elsinore and Helsingborg.* Mechanical and electrical data of this cable are given in the table. The dielectric was gutta percha, and, except in respect of the iron wrapping, the cable did not differ materially from the ordinary type of submarine cable. This was followed, as will be seen from the table, by various paper-insulated cables having the conductors wrapped with a single layer of 0·012" iron wire. The cable shown in *Fig.* 11, Appendix VI., is that laid in July, 1904, and is distinguished by the letter E in the table. Each copper conductor consists of a central wire about 0·089" in diameter surrounded by three copper strips each 0·094" wide and 0·020" thick. The sectional area of the copper is approximately 0·0124 square inch, and the weight per knot 285 lbs. The iron wrapping consists of three layers of 0·008" wire, and the insulator is gutta percha having an external diameter of 0·354". The four cores are laid up with an inner serving of tanned jute and an outer serving of tarred jute yarn to a diameter of 1·18", and sheathed with 15 galvanized iron wires of roughly trapezoidal section. The external covering appears to be the usual tarred yarn and compound.

The electrical constants of the cable per knot from Mr. Krarup's figures are as follows :—

Resistance. Ohms per Knot of Conductor.		Capacity. Microfarads per Knot of Conductor.		Self-Inductance. Millihenries per Knot.	
Steady Current.	Alternatiug Current. $n=900$.	Steady Current.	Alternating Current.	With Iron.	Without Iron.
3·971	4·175	0·4983	0·4454	8·07	0·93

Of the paper-insulated lead-covered cables the Dano-German telephone cable laid between Fehmern and Laaland in 1907 may be taken as representative. The copper conductor with its triple soft iron wire wrapping is precisely similar to that used in the Seeland-Samsö-Jutland cable described above. The insulator consists of paper cord laid on in an open spiral followed by a close wrapping of paper ribbon up to a diameter of 0·303". Four of the cores so formed are stranded together with the necessary worming and then covered with paper to a diameter of 0·787". The diagonal distance apart of the cores, centre to centre, is 0·413". The core after being thoroughly dried is next sheathed with two layers of lead alloyed with 3 per cent. of tin, each layer being 0·055" thick. The lead sheath is seamless, water-tight, and continuous throughout the entire length of the core. Outside the lead sheath is a double layer of asphalted paper and a layer of jute and compound. The armour consists of 13 galvanized iron wires or strips of trapezoidal section $\left(\frac{0·315+0·252}{2}\times 0·157 \text{ square inches}\right)$, and over this is a double layer of jute and compound.

To prevent the destruction of the cable by the puncture of the lead sheath at any point solid plugs 1 metre (3·28') long are inserted at every 150 metres (164 yards).

Resistance per knot of loop, 8·924 ohms ... ...
Capacity per knot of loop, 0·0872 microfarad... ... ... } Continuous current.
Capacity per knot of loop, 0·0770 microfarad ... . Alternating current.
Inductance per knot of loop, 18·26 to 18·09 millihenries.

* *Moderne Telefonkabler*, by C. E. Krarup. *Elektroteknikeren*, December 10th, 1904.

Digitized by Google

APPENDIX VIII.

FORMULÆ FOR CALCULATING ATTENUATION CONSTANT OF "CONTINUOUSLY" LOADED CIRCUITS.

Values of the inductances obtained by the employment of a continuous solid iron envelope over copper conductors are calculated from the formula—

$$L = 4\left[\log\frac{2d}{r} + \tfrac{1}{4} + (\mu - 1)\log\frac{r+t}{r}\right] 10^{-4} \text{ per kilometre,}$$

where

L = inductance in henries.
$2d$ = distance between centre conductors in cms.
r = radius of each conductor in cms.
μ = permeability = 120.
t = thickness of iron covering.

In the case of the Danish cable tested by Mr. Martin (Cable E, Appendix VII.)—

$2d = 1{\cdot}275$ cms.
$r = 0{\cdot}16$,,
$t = 0{\cdot}06$,,

Then $L = 0{\cdot}016$ henries per kilometre.

The values of the inductances* obtained by the employment of a wire-wound continuous envelope over the copper conductors—

$$L = \left[2\pi\left(\frac{1}{R} + \frac{1}{R_2} + \ldots + \frac{1}{R_v}\right)\frac{r^2}{2r+g}\left(\frac{\mu}{1+a} + f\right) + 2\log\frac{2r_3 - r_2}{r_2}\right] 10^{-4} \text{ henries per km. of loop,}$$

where

$$f = \frac{4}{\pi} - 1 + \frac{2g}{\pi r},$$

and

$$a = \mu\frac{r\sqrt{gr}}{8\pi R^2 \tan^{-1}\cdot\frac{r}{\sqrt{gr}}}.$$

r = radius of iron wire in cms.
v = number of layers of iron wire.
g = gap between convolutions of iron wire in cms.
R_1 = mean radius of first layer of iron wire in cms.
R_2 = mean radius of second layer of iron wire in cms.
R_3 = mean radius of third layer of iron wire in cms.

$$R = \frac{1}{v}(R_1 + R_2 + R_3).$$

r_2 = outer radius of iron wrapping in cms.
r_3 = half the distance in cms. between centres of conductors.
μ = permeability of iron.

In the case of the Danish cable tested by Mr. Martin (Cable E, Appendix VII.)—

$r = 0{\cdot}01$ cms.
$v = 3$.
$g = 0{\cdot}005$ cms.
$R_1 = 0{\cdot}17$,,
$R_2 = 0{\cdot}19$,,
$R_3 = 0{\cdot}21$,,
$r_2 = 0{\cdot}22$,,
$r_3 = 0{\cdot}6363$,,
$\mu = 120$.
$S = 12 \times 10^{-6}$

(This value for leakance is adopted as being 100 times the capacity).

Then $L = 0{\cdot}0102$ henries/km. of loop.

* This is from Larsen's formula (*Elektrotechnische Zeitschrift*, Vol. 29, p. 1031, equation (17)). The coefficient 2 is wanting in the expression as there found, because the author reckons inductance, etc. "für 1 km. einfache Leitung."

Digitized by Google

Note.

In the tables of Appendices IX. and IXA. effective resistances are calculated. The following expression* has been used :—

Extra resistance due to eddies in the iron is

$$\Delta w = 10^{-13}\, 8\pi^4 \left(\frac{1}{R_1}+\frac{1}{R_2}+\ldots\frac{1}{R_n}\right)\frac{1}{\rho}\left(\frac{\mu}{1+\alpha}\right)^2 n^2\,\frac{r^4}{2r+g}\ \text{ohms/km. of loop,}$$

where

ρ = specific resistance of iron in ohms/sq. cm./cm.
n = frequency in periods per second,

and lengths are in cms.

Further, the hysteresis loss is taken as half of the eddy-current loss in the iron. The reason for so doing lies in this: that Larsen† finds such is very nearly the value of the hysteresis loss at 765 periods per second for a cable whose separate cores are very nearly similar to those of the actual cable, but which lie close together, instead of being separated as in the quad-pair arrangement to which the tables of Appendices IX. and IXA. refer.

Finally, the capacity of the cable, used in the tables to calculate β, is found from the usual expression, substituting for the radius of the copper the other radius of the iron wrapping.

APPENDIX IX.

Constants of a "Continuously" Loaded Danish Telephone Cable compared with the Constants of the same Cable without Loading and with Coil Loading.

Cable Core Details.			Constants per Knot of Loop at 750 p.p.s.					Attenuation Constant β.			
Overall Diameter of Copper.	Loading.	Overall Diameter of Gutta Percha.	Resistance Ohms.		Inductance in Millihenries.	Capacity in Microfarads.	Leakance in Mhos.	Per Kilometre.	Per Statute Mile.	Per Nautical Mile.	
			Direct Current.	750 p.p.s.						Calculated.	Observed.
Mils.		Mils.									
126	Three layers of 7·88 mils iron wire 101·5 turns per inch ..	355	7·96	8·88	19·00	0·253	$2\cdot4\times10^{-5}$	0·0106	0·0171	0·0197	0·0296
126	Unloaded ...	355‡	7·96	7·96	2·00	0·175	$2\cdot4\times10^{-5}$	0·0199	0·0320	0·0369	—
126	Coils of 100 m.h. every 1·075 knots ... Steady current resistance, 2·25 ohms . Resistance at 750 p.p.s., 6 ohms	335§	10·06	13·55	95·00	0·186	$2\cdot4\times10^{-5}$	0·0080	0·0128	0·0148	—

‡ Space occupied by iron in first example filled with gutta percha.
§ Weight of gutta percha same as in first example.

* Larsen, *Elektrotechnische Zeitschrift*, Vol. 29, p. 1032, equation (30).
† *Elektrotechnische Zeitschrift*, Vol. 29, p. 1033, Beispiel 2.

Digitized by Google

APPENDIX IXA. (*Amended*).

CONSTANTS OF THE ANGLO-FRENCH COIL LOADED TELEPHONE CABLE COMPARED WITH THE CONSTANTS OF THE SAME CABLE WITHOUT LOADING AND CONTINUOUSLY LOADED.

Cable Core Details.			Constants per Knot of Loop.				Attenuation Constant.				
			Resistance Ohms.		Direct Current.				Per Nautical Mile.		
Overall Diameter of Copper.	Loading.	Overall Diameter of Gutta Percha.	Direct Current.	750 p.p.s.	Inductance in Millihenries.	Capacity in Microfarads.	Per Kilometre.	Per Statute Mile.	Calculated.	Observed.	Characteristic Impedance = Z_0.
Mils.		Mils.									
106·2	Three layers of 7·88 mils iron wire 101·5 turns per inch ...	405*	14·95	16·06	22·00	0·181	0·0124	0·0200	0·0230	—	—
106·2	Unloaded ..	390	14·95	14·95	2·00	0·138	0·0278	0·0447	0·0520	0·0524	—
106·2	Coils of 100 m.h. every knot .. Steady current resistance, 2·25 ohms ... ... Resistance at 750 p.p.s., 6 ohms	390	17·20	20·90	102·00	0·138	0·0091	0·0147	0·0170	0·0166	$838\sqrt{0·54}$

* Weight of gutta percha same as in Cases 2 and 3. Length of Channel cable = 20 knots.

APPENDIX X.

MR. H. R. KEMPE'S METHOD OF CALCULATING THE ATTENUATION OF LOADED CIRCUITS, ETC.

The formula

$$\beta = \sqrt{\tfrac{1}{2}\left[\sqrt{(R^2+p^2L^2)(S^2+p^2K^2)}+RS-p^2LK\right]}$$

is not a convenient one for general use, owing to the fact that the value of

$$\sqrt{(R^2+p^2L^2)(S^2+p^2K^2)}+RS$$

is, in the majority of cases, so very nearly equal to the numerical value of p^2LK that the equation cannot be correctly solved unless the terms are worked out to a very large number of places of figures; also it is perferable to express L, K, and S in millihenries (l), microfarads (k), and ohms (ω), rather than in henries, farads, and mhos; also for the cable manufacturer, it is more convenient to deal with a single than with a looped circuit.

The formula in this case becomes

$$\beta = \frac{\sqrt{k}}{20}\sqrt{\sqrt{R^2+(5l)^2}-5l+\frac{200R}{\omega k}+0·000128\sqrt{R^2+(5l)^2}} \quad \ldots\ldots\ldots(1)$$

The value of ωk for ordinary gutta-percha-insulated cores may be taken to be 12,500 approximately, so that

$$\beta = \frac{\sqrt{k}}{20}\sqrt{\sqrt{R^2+(5l)^2}-5l+0·016R+0·000128\sqrt{R^2+(5l)^2}} \quad \ldots\ldots\ldots(2)$$

R being the conductor resistance r, plus the "effective resistance" ρ of the inductance coils, *i.e.*, $R = r+\rho$.

Digitized by Google

In the case of well-constructed inductance coils the effective resistance is 6 ohms for every 100 millihenries of inductance, *i.e.*, $\rho = 0{\cdot}06l$, so that $R = r + 0{\cdot}06l$. Formula (2) is a general one, but when l is larger than R (in numerical value), which is usually the case, then

$$\beta = \frac{r + .14l}{63{\cdot}2}\sqrt{\frac{k}{l}}$$

r being the conductor resistance exclusive of the resistance of the inductance coils.

A minimum value is given to β if $r = 0{\cdot}14l$, in which case

$$\beta = 0{\cdot}01183\sqrt{kr},$$

and

$$l = 7{\cdot}14r.$$

These two equations are all that is necessary for calculating the inductance which should be given to a cable to make it most efficient telephonically, and also to determine the value of β under this condition.

It may be remarked that the equation

$$\beta = 0{\cdot}01183\sqrt{kr}$$

indicates that a properly loaded cable, in relation to telephonic efficiency, does not follow a "kr" but a "$\sqrt{kr}$" law, and it also follows that the efficiency is inversely proportional to the length, and not to the square of the length.

The value of the leakance is an important factor, and could this be reduced tenfold, the value of β could be reduced about 40 per cent.; and further, if it were possible to reduce the leakance practically to zero, *i.e.*, to make the insulation practically infinite, then the value of β could be reduced 50 per cent., which is the minimum value which could be given to it without reducing the effective resistance of the coils below 6 ohms per 100 millihenries, a result which has so far proved not to be possible.

In comparing the improvement which can be obtained by loading a cable, the fact that there is a normal inductance must be taken into consideration. This normal inductance is about 1 millihenry per knot approximately, but a number of successful experiments have been made to determine its exact value.

The possible improvement from loading diminishes as the conductor resistance diminishes (since, as pointed out, for best conditions $l = 7{\cdot}14r$), thus, the possible improvement for a 1-ohm conductor is but one-half that for a 5-ohm conductor. For long-distance speaking in this country, heavy overhead conductors are necessary not only from the point of view of low resistance, but also in regard to the effect of low insulation resistance, which, owing to climatic conditions, it is impossible to avoid. Loading of such lines would, even if possible, be of comparatively little value.

The following formulæ have been developed, based on general principles, and enable various conditions to be calculated :—

Formulæ for Loading Coils.

β = attenuation constant per knot.
W = weight of gutta percha per knot.
w = weight of copper per knot.
n = ratio of weight of copper to weight of gutta percha.
$\mathcal{L}$ = total cost of materials of core.
a = cost per lb. of gutta percha (in £s).
b = cost per lb. of copper (in £s).
k = capacity per knot in microfarads.
r = resistance per knot in ohms.
l = total inductance per knot in millihenries.
n_1 = ratio of effective resistance of inductance in ohms to inductance in millihenries.
d = distance apart of inductances.
l_1 = inductance per coil.

Digitized by Google

$$rk = \frac{1000\beta^2}{n_1 + 0{\cdot}08}$$

$$\beta = \sqrt{\frac{k}{\mathcal{L}}\left(\frac{a}{n} + bn\right)} \times 1{\cdot}192\,(n_1 + 0{\cdot}08)$$

$$\mathcal{L} = \frac{k}{\beta^2}\left(\frac{a}{n} \times bn\right) \times 1{\cdot}192\,(n_1 + 0{\cdot}08) \text{ or } = aW + bw$$

$$n = \frac{w}{W}$$

$$k = \frac{0{\cdot}320}{\log\left(\frac{9{\cdot}076}{n} + 1\right)}$$

$$W = \mathcal{L}\,\frac{n}{a + bn}$$

$$r = \frac{1192}{W} \text{ or } = \frac{1192}{\mathcal{L}\,\frac{n}{a + bn}}$$

$$l = \frac{R}{n_1 + 0{\cdot}08}$$

$$d = \sqrt{\frac{20}{kl}}$$

$$l_1 = \sqrt{\frac{20l}{k}} \text{ or } = \frac{d}{\sqrt{l}}$$

The cost, as regards the materials of the core (gutta percha and copper), of obtaining a low attenuation constant, increases as the inverse square of the constant, *i.e.*, if we double the length of a cable we double the cost and double the attenuation constant, and to halve this doubled constant the size of the conductor and the thickness of the dielectric must be increased; the cost of this increase would be double that of the original cable, length for length.

LENGTH OF COPPER WIRE LOOPS CORRESPONDING TO CENTIBETAS.

Centibetas.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100	110.	120.	130.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
200-lbs. wire... ...	14	28	43	57	71	86	100	114	129	142	157	171	186
300-lbs. wire... ...	20	40	61	81	101	121	141	162	182	202	222	243	263
400-lbs. wire	25	51	77	102	128	153	179	204	230	255	281	306	332
600-lbs. wire... ...	36	72	108	144	180	216	252	288	324	360	396	431	467
800-lbs. wire	44	88	132	177	221	265	309	353	397	441	485	530	574

Centibetas.	140.	150.	160.	170	180.	190.	200.	210.	220.	230.	240.	250.	260.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
200-lbs. wire... ...	200	214	228	243	257	271	285	300	314	328	343	357	371
300-lbs. wire... ...	283	303	324	344	364	384	404	425	445	465	485	506	526
400-lbs. wire... ...	358	383	409	434	460	485	511	536	562	588	613	639	664
600-lbs. wire... ...	503	540	575	611	647	683	719	755	791	827	863	899	935
800-lbs. wire... ...	618	662	706	750	794	839	883	927	971	1,010	1,060	1,100	1,145

1 knot of cable (Anglo-French loaded) = 1·67 centibetas.
1 statute mile (Anglo-French loaded = 1·44 ,,
484 centibetas = limit of commercial speech.
Exchanges and subscribers = 216 centibetas.

Example.—With 100 miles of Anglo-French loaded cable, how many miles of 600-lb. trunk wire can be worked through?

$100 \times 1{\cdot}44 = 144.$ $484 - 216 = 268.$
$268 - 144 = 124 = 445$ miles of 600-lb. wire.

Digitized by Google

APPENDIX XI.

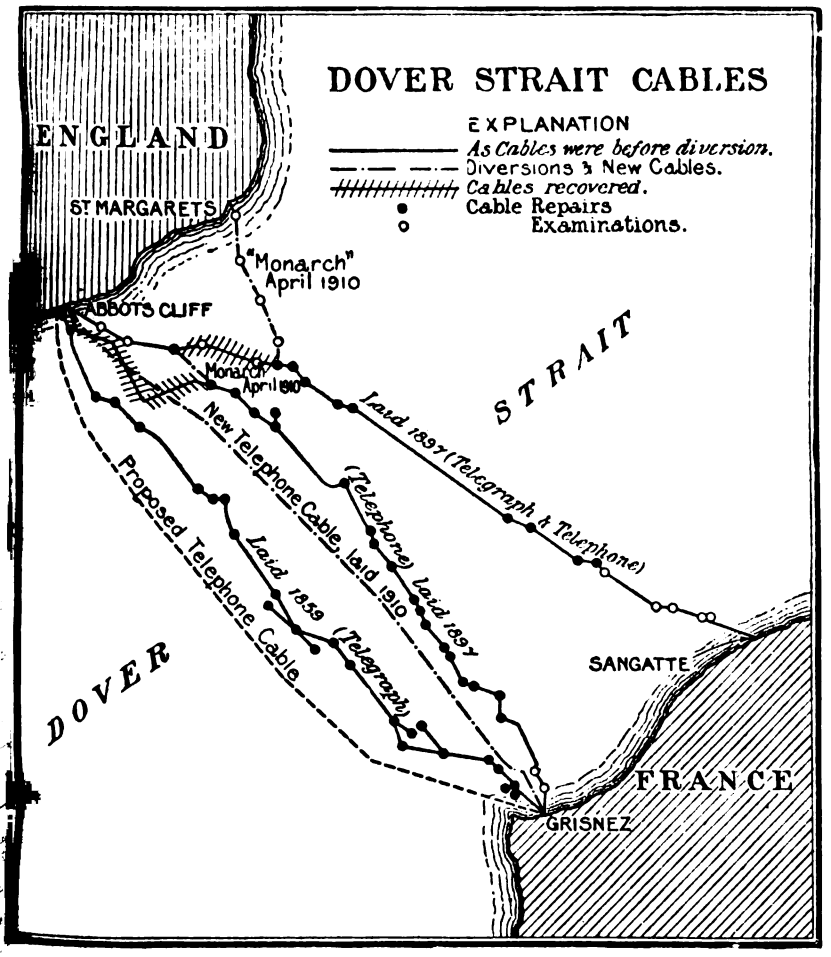


FIG. 12.

APPENDIX XII.

TESTS BY MR. L. B. TURNER ON THE LOADED CHANNEL CABLE, TO DETERMINE BY DIRECT MEASUREMENT THE SENT AND RECEIVED CURRENTS.

The experiments were made in the Abbot's Cliff Cable Hut on October 14th, 1910.

The high-frequency current used in the tests was supplied from the General Post Office, London, over a pair of telephone wires.

The arrangement of the apparatus was thus :—

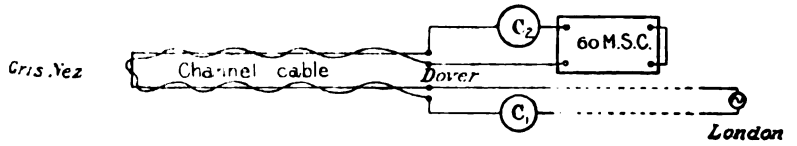


FIG. 13.

Digitized by Google

To prevent appreciable reflection-effect at the far end of the circuit it was found that rather more than 20-m. standard cable must be inserted. Actually 60-m. standard cable was used.

The ammeters C_1 and C_2 were Duddell thermo-instruments. Their heaters had resistances of roughly 170 and 4 ohms respectively.

There was some difficulty in obtaining a uniform supply from the alternator, and consequently accurate measurements could not be made. The table below includes the only results on which, owing to the unsteadiness of the supply of high-frequency current, any reliance can be placed.

Frequency p.p.s.		C_1 Milli-amperes.	C_2 Milli-amperes.	$\therefore e^{\beta l}$ $(=C_1/C_2)$.	$\therefore \beta l$.	$\therefore$ Me βl.
Readings.	Mean.					
1,720	—	8·92	2·23	4·00	1·390	
—		6·42	1·80	3·56	1·270	1·33
1,232	—	7·97	3·09	2·57	0·940	
—		8·98	3·38	2·65	0·970	0·96
1,060		6·20	2·54	2·39	0·870	0·87
762	—	7·83	4·28	1·83	0·605	
—		7·02	3·91	1·80	0·590	0·60
744		5·76	3·09	1·85	0·615	
752		4·06	2·33	1·74	0·540	
772	756	5·76	3·09	1·84	0·610	0·59

The following graph is plotted between the mean values for frequency and for βl. l, the length of loop under test was 40·0 knots.

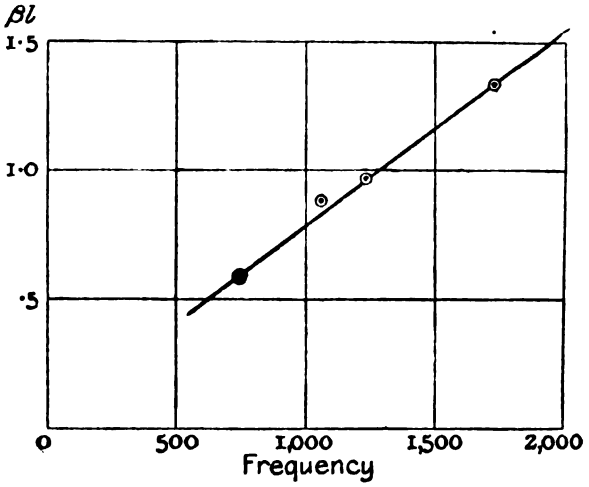


FIG. 14.

To compare these results with the value of β as indirectly obtained by speech tests we proceed thus. That single frequency which best represents the voice, so far as volume of sound is concerned, has been found to be about 800 p.p.s.*

From the graph, for this frequency

$$\beta l = 0{\cdot}63.$$

i.e.,

$$\beta = 0{\cdot}0158.$$

Assuming 800 p.p.s. to be the simple equivalent voice frequency, the value of the attenuation constant as found by speech test comparisons with standard cable is

$$\beta = 0{\cdot}0169.$$

* F. Breisig, *Berichte der Deutsche Physikalische Gesellschaft*, Heft 5, 1910

Digitized by Google

CORRESPONDENCE.

A PONTOON BRIDGE FOR STEAM TRANSPORT.

SIR,

With reference to the paper of Capt. Carey, R.E., in the February number of the *R.E. Journal* on heavy pontoon bridging may I call attention to one or two points. This question is one of great importance at the present time and we should be much indebted to Capt. Carey for throwing some light on it by his investigations. But I should like to point out that he is hardly fair on the present equipment in one or two particulars. These are:—

(i.). The allowance for superstructure of 200 lbs. per foot-run is needlessly high.

(ii.). An allowance of 100 per cent. for impact is not required for the baulks of a bridge of which the supports rest on water. 50 per cent. has always been considered to be sufficient and when the elasticity of a floating bridge is taken into account, it seems as it even this allowance were too great.

(iii.). The safe dead central load in pounds of a pontoon baulk over a span of 15′ is 2,043 and not 1,886, since the width is $3\frac{1}{4}''$ and not 3″.

Further, in Design I., which is the really important one, it is stated that the pontoons *b*, *c* and *d* "will sink evenly" under the load on *c*. This cannot be the case since the baulks deflect under the load.

However Capt. Carey's calculation of the number of baulks required gives a total of just over 14, after the necessary corrections have been made for (ii.) and (iii.) above, *i.e.* altering the 1,886 lbs. to 2,043 and the 943 to 1,362. This confirms the calculations for, and the practical experience of, the bridge designed in the Fortification School and tested at Upnor, where it was found that 14 baulks *will* take the specified load without any damage or permanent deflection in the baulks. This bridge is shown in *Fig.* 14 of the first article in the *Journal* for February.

I am, etc.,

J. C. MATHESON,

Major, R.E.

Chatham, February 19th, 1912.

The Editor, *R.E. Journal.*

Digitized by Google

BOOKS RECEIVED.

SPONS' ARCHITECTS' AND BUILDERS' POCKET BOOK, 1912. Memoranda Section. Edited by Clyde Young, F.R.I.B.A., and Stanford M. Brooks, L.R.I.B.A. Price 2s. 6d., post free 2s. 8d. E. & F. Spon, 57, Haymarket, W.

SPONS' ARCHITECTS' AND BUILDERS' POCKET PRICE BOOK AND DIARY, 1912. Edited by Clyde Young, F.R.I.B.A., and Stanford M. Brooks, L.R.I.B.A. Price 2s. 6d., post free 2s. 8d. E. & F. Spon, 57, Haymarket, W.

ETUDES TACTIQUES D'ARTILLERIE. M. Blaise, Capitaine d'Artillerie Breveté. Préface de M. le Général de Lastours, Commandant la 3e Division de Cavalerie. Les desiderata et les possibilités.—La convergence des efforts.—Organisation du Commandement.—Centralisation et décentralisation.—Actions convergentes et actions parallèles.—Les prévisions.—La liaison des armes et les groupements mixtes.—Le renforcement.—Les emplois spéciaux.—Librairie Chapelot, 30, Rue Dauphine, Paris.

THE COMING TRIUMPH OF CHRISTIAN CIVILISATION. Capt. J. W. Petavel, late R.E. London, Geo. Allen & Co., Ltd, 44 and 45, Rathbone Place.

A B C OF HYDRODYNAMICS. Lt.-Col. R. de Villamil, R.E. (Ret.). Price 6s. net, 6s. 4d. post free in the U.K. Messrs. E. & F. Spon, Ltd., 57, Haymarket, London, S.W.

THOMASON CIVIL ENGINEERING COLLEGE CALENDAR, 1911–12. Allahabad, 1911.

HANDBOOK OF THE LAND FORCES OF BRITISH DOMINIONS, COLONIES AND PROTECTORATES (OTHER THAN INDIA). Part I. THE DOMINION OF CANADA. General Staff, War Office, S.W. H.M. Stationery Office, Westminster, S.W. (*For Official use only*).

HISTORICAL PAPERS ON MODERN EXPLOSIVES. By George W. MacDonald, M.SC. (MELB.), with an Introduction by Sir Andrew Noble, Bt., K.C.B., F.R.S. Price 7s. 6d. net. Whittaker & Co., 2, White Hart Street, Paternoster Square, E.C.

Digitized by Google

A PONTOON BRIDGE FOR STEAM TRANSPORT.

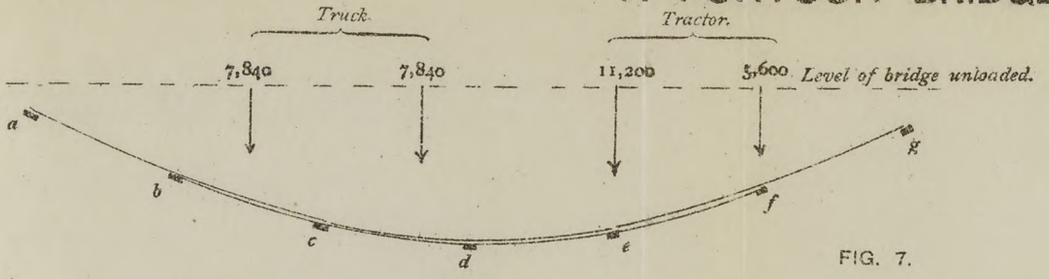


FIG. 7.

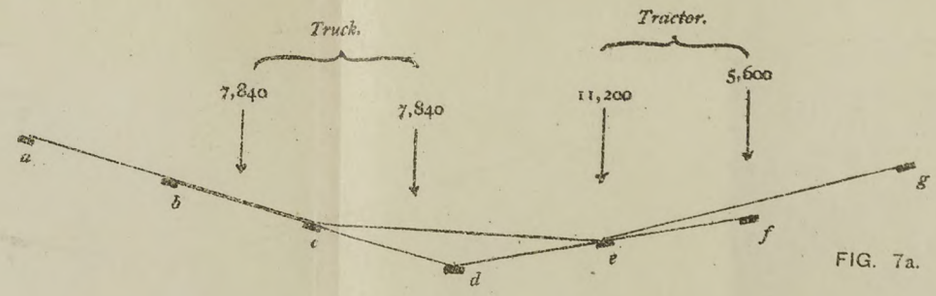


FIG. 7a.

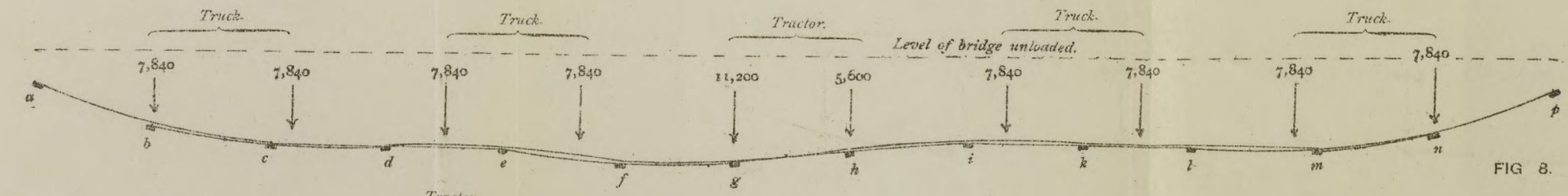


FIG 8.

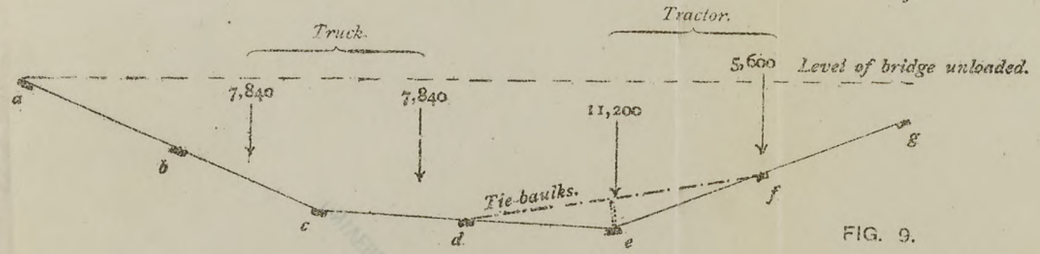


FIG. 9.

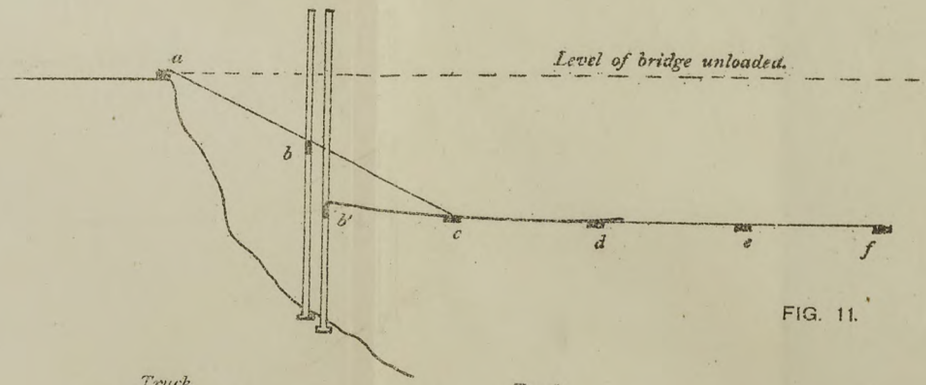


FIG. 11.

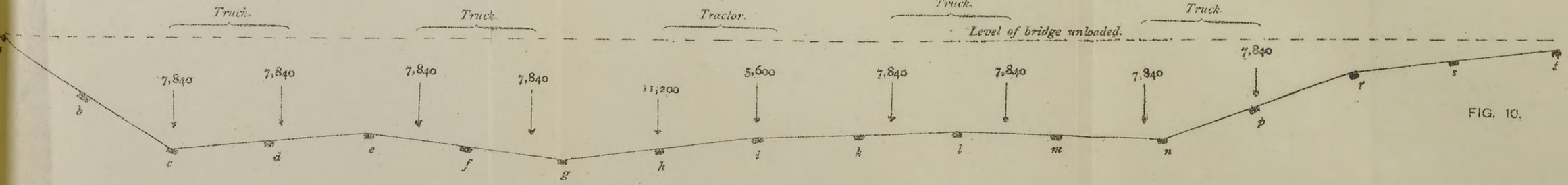
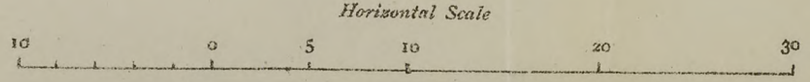
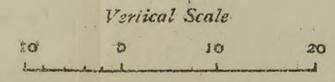


FIG. 10.

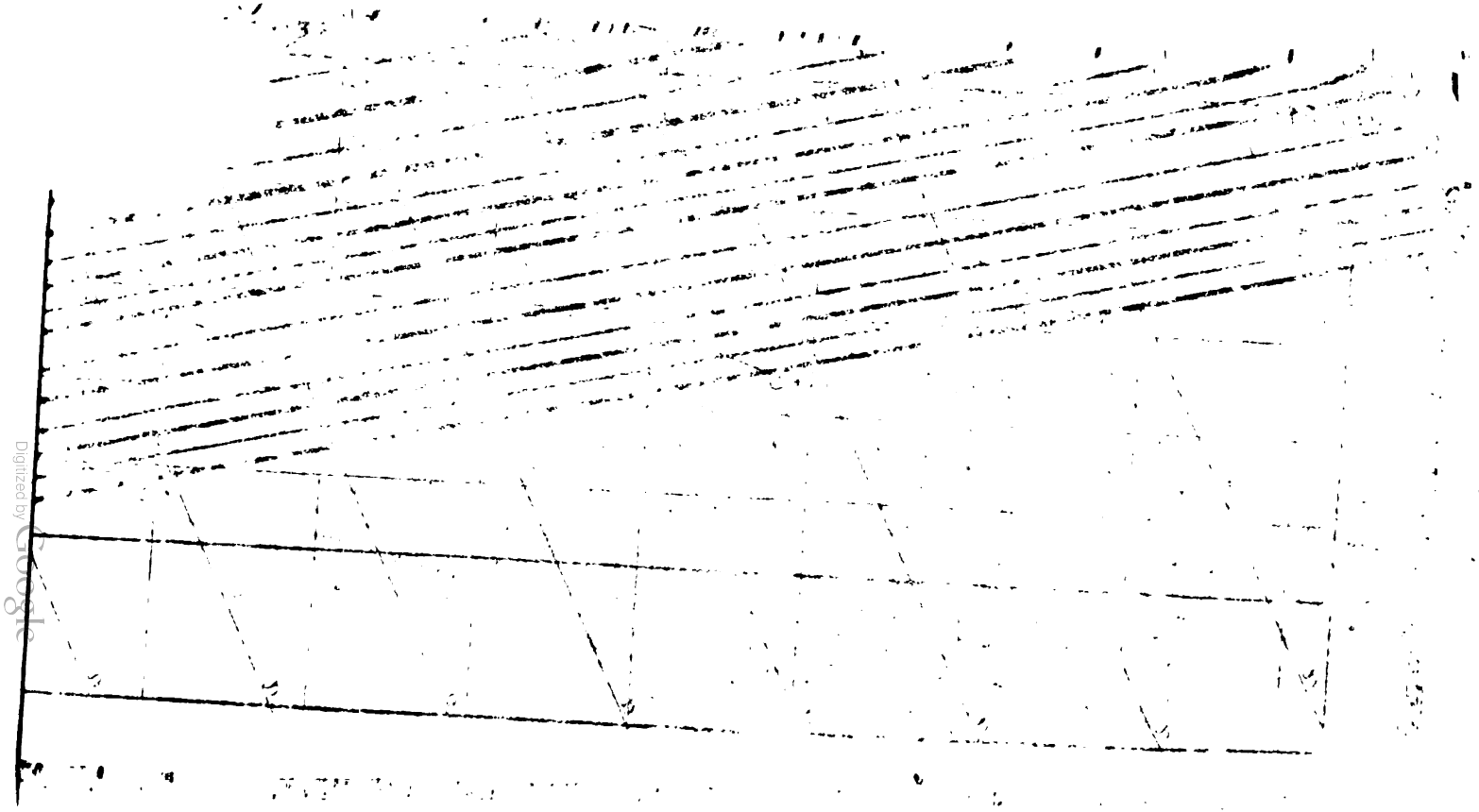




Digitized by Google

Digitized by Google

Digitized by Google



Digitized by Google

THE HOLDING POWER OF EARTH IN CONNECTION WITH ANCHORAGES FOR MILITARY BRIDGES.

By Capt. C. E. P. Sankey, R.E.

Anchorages buried in the earth have to be used in various military bridges, notably suspension, tension, and cantilever bridges. The subject is an important one, but it would almost seem that its importance has been under-estimated, as it is more often than not the case when a bridge of any of these types fails, to find that the failure is due to the dragging of the anchorage; an examination of the figures on which the calculations for such anchorages are based will therefore not be without interest.

The pull that may safely be placed on an anchor beam in the earth depends upon a variety of factors, one of the most important being the holding power of the earth itself. This factor is characterised by not being easily measured directly, owing to the magnitude of the stresses involved, as any but full-size experiments are most unsatisfactory, and by not being readily calculable by any formula in common use.

It is therefore necessary to have recourse to tables of accepted results or their equivalent; the tables one naturally turns to, are the two in *Instruction in Military Engineering*, Part III., para. 34 and 35. The former gives the relative holding power of various soils, and the latter some definite values for one particular nature of earth, taken as the standard for the purposes of the first table. Considering the latter table first, it will be seen that it gives the ultimate resistance in lbs. per square foot, to a pull on a buried anchor beam, the values varying with the mean depth of the anchorage and with the inclination of the pull.

In order to appreciate more distinctly the nature of this table, and to discover the basis on which it is founded, the first step seems to be to plot graphically the values given, with the depths as ordinates and the resistances per square foot as abscissæ. Anyone who has plotted this table will have been struck by two things, its suspicious degree of accuracy, the ultimate resistance to a vertical pull on an anchor whose mean depth is 5′ being given to five significant figures, and also the fact that the chart so obtained takes such a curious form that one is led to doubt even the approximate accuracy of some of the values.

As a next step, it is desirable to compare this table with some other authority, but here, at all events as far as the author is concerned, a difficulty arises. He has not been able to find any other table of a

Digitized by Google

similar nature, probably due to the fact that such results have an interest almost entirely confined to improvised or military bridges, the anchoring arrangements in permanent structures owing their security to very different considerations.

It is therefore necessary to trace the origin of these tables, to see if anything can there be found to throw light upon these anomalies. These tables appeared, in their identical form, in one of the series of very valuable articles contributed by Lieut. (now Major-General Sir Thomas) Fraser, to the *Professional Papers* of the Corps of Royal Engineers. The paper in question is entitled "Experiments on the Holding Power of Earth, and the Strength of Materials," and formed No. VIII. of Volume XXII.

The present author has no intention of criticising the experiments there recorded, but it is possible to divide any paper of this nature into two portions, the results of the actual experiments, and the deductions made therefrom. It is therefore proposed to accept the results obtained as correct, within the limits of accuracy appertaining to the subject and the apparatus, and to limit the investigation to the laws deduced from them.

Table I., in the *Paper* referred to, gives the results of the experiments; these were 36 in number, and varied as regards soil, inclination of pull, depth, extent, surface, and shape of the anchor. Table II., reproduced in *Instruction in Military Engineering*, Part III., para. 34, gives the relative holding power of different soils, and Table III., reproduced in para. 35, gives definite values for loam.

In Table III., certain values are marked with an asterisk to show that they have been derived from calculation, and are not experimental values; these may obviously be removed for the present purpose, and the table will then appear as follows :—

	Vert.	1/1.	1/2.	1/3.	1/4.
1′	808	933	—	—	—
1′ 6″	—	—	2100	—	—
2′	1925	2700	3880	4032	4370
3′	3024	4400	—	—	—
4′	5470	8000	—	—	12260
5′	14112	22000	—	—	—

Taking the columns in order, these values may be examined to see from which experiments each was derived, and the results of this examination are set forth in tabular form in Appendix A. When it

Digitized by Google

is remarked that out of the 15 values recorded in this table, 10 are dependent on the result of a single experiment each, the fact that they do not plot in continuous curves is no longer to be wondered at. It is, on the other hand, striking evidence of the skill and care with which these experiments were carried out, that they should plot as well as they do.

The results of the remaining experiments may be analyzed as follows:—9, 10, 11, 12, 13, and 14, were carried out in gravel, 16, and 17, in sand, and 35, and 36, in clay; from these experiments the comparative Table II. is compiled. In experiment 15, the buried anchor was a fascine; it was in gravel, and its results may or may not have been used for Table II. Experiment 34 was the case of an anchor with a considerable width or depth, and from it is deduced the statement in *Instruction in Military Engineering*, Part III., para. 34, as to anchorages with faces several feet deep. Experiment 19 was the case of an anchor 3′ in loam, the inclination being 1/3; the result, 4,494 lbs. per square foot, does not appear to have been used. In experiment 32, the inclination was 1/2·5; the anchor was buried 2′ in loam, and gave 7,837 lbs. per square foot.

It is now proposed to find some formula, if possible rational in form though probably with empirical coefficients, that will combine the factors whose variation may be supposed to affect the result, and by applying the experimental values to this formula, it will be possible to find approximate values for these coefficients. These factors may be classified as follows:—

The inclination of the pull.
The weight of the soil.
The angle of repose of the soil.
The tenacity or cohesion of the soil.
The depth of the anchorage.

There are undoubtedly several other factors that may also influence the result, such as duration or suddenness of the pull, but these can be omitted in a calculation that by the nature of things can never pretend to a high degree of accuracy, and their effect will have to be covered by the factor of safety.

If in the first place it is assumed that the particles of earth have no mutual tenacity at all, the resistance offered by unit area of an anchorage can be expressed, by a similar process of reasoning to that given by Rankine* for vertical and horizontal pressures, in the following formula:—

$$r = w \cdot d \; \frac{\frac{1+\sin\phi}{1-\sin\phi} - \frac{1-\sin\phi}{1+\sin\phi}}{\cos\alpha + \sin\alpha \, \frac{1+\sin\phi}{1-\sin\phi}}$$

* *Applied Mechanics*, 7th edition, 1873, Part II., Chapter II., Section 3.

Digitized by Google

where r is the ultimate resistance per unit of area, w the weight of the soil per unit of volume, d the mean depth of the anchor, its breadth being small compared to its length, α the angle of inclination of the pull to the horizontal, the ground surface being also considered horizontal, and ϕ the angle of repose of the soil. If an actual example is substituted in this formula, it will be seen that in general the results given by it are far too small, but it has an importance, as it gives a minimum below which the resistance cannot fall, short of alteration in the physical properties of the earth, no matter how much the ground may be broken up by careless digging or frequent use; it might indeed be advisable to adopt such values in the case of an anchorage required to last for some time. The formula is also useful in the case of materials such as shingle, whose cohesion is negligible. As the value given is a minimum one, a factor of safety of unity can be used.

As a rule, however, earth has cohesion, and, as shown by experimental results, to a considerable extent. A rational formula to express the result of this cohesion would be very complicated and, owing to the variability of the conditions, hardly practical. It seems fair, however, to assume that the resistance to rupture will vary with the square of the depth, whether the cohesion is considered as bringing the resistance of the soil within the nature of that of a thick fixed plate, or within that of a cantilever, of which alternatives the latter seems preferable, because the earth has to be cut away on one side to allow of the introduction of the anchor beam. It is natural also to suppose that the resistance will increase as the angle of inclination of the pull decreases, and this is borne out by experiment; it is not easy to give a good reason for any empirical allowance for this purpose, but the function used in the expression given below has the merit of increasing in the required way, and will probably be sufficiently accurate for practical purposes. A measure of the cohesion of the earth can be obtained by the height to which it will stand truly vertical when freshly cut, together with its weight aad its angle of repose, the expression used below being derived from a consideration of the equilibrium of a mass of earth, triangular in section, bounded by horizontal and vertical planes, and the plane of the angle of repose.

The following empirical expression is therefore adopted for the resistance of a soil with cohesion between its particles:—

$$r = \mathrm{K}w \,.\, d^2 h \sin 2\phi \{1 + \mathrm{N}(1 - \sin \alpha)\}$$

where h is the height to which the soil will stand truly vertical when freshly cut, the other symbols having the same meaning as before, and where K and N are coefficients, as yet undetermined. By substituting in this expression the values given by the experimental

Digitized by Google

results, the following values are obtained, by the method of Least Squares, for the undetermined coefficients :—

$$K = \cdot 49$$

$$N = 2 \cdot 37$$

the units used being the foot and the pound. The expression is at best an approximate one, more especially as the values for h had to be assumed for the soils concerned from a remark made in the paper as to their nature, and the simpler values given in the following expression can be adopted, without any loss of accuracy, for the safe resistance per square foot.

$$r = \frac{1}{S} w d^2 h \sin 2\phi \, (1 \cdot 5 - \sin \alpha)$$

where S is the factor of safety adopted. In cases where the ground surface is not horizontal, α can be taken as the angle between the direction of the pull and the ground surface, and d should be measured at right angles to this surface.

To save the labour necessary for working out this expression in any given case, it has been put in the form of a graphical chart (see *Plate*) ; this is more concise than a tabular statement, because a different table would be required for each kind of soil, and even then considerable arithmetical work would be necessary in the interpolation of values. The chart gives the safe resistance per square foot of an anchor beam, whose length is considerable in proportion to its breadth ; when its breadth is also considerable, as in the case of the built-up anchorage shown in *Instruction in Military Engineering*, Part III., *Plate* I., *Fig.* 13, it should be regarded as consisting of several portions, none of which should exceed say 1′ in breadth, and the resistance of these several portions added together. In calculating the length of an anchor beam required in any case, an allowance must be added for those portions of it opposite the cable trenches, as these can offer no resistance to the pull ; this allowance has been made in the chart.

The chart also gives the minimum resistance offered by earth in a purely granular state, without tenacity or cohesion ; the expression only includes a factor of safety of unity, for the reasons given previously. In cases where the values given by the former portion of the chart are less than this value, this latter can be adopted. It can also be used for shingle and other similar materials.

Digitized by Google

APPENDIX A.

Inclination.	Depth.	Tabular Value.	No. of Experiment.	Experimental Value.	Remarks.
Vertical	1′	808	3	1166·6	Mean 808·3.
			8	450	
	2′	1925	4	1700	Mean 1925.
			6	2150	Expts. 1, and 2, each giving about 900, ignored.
	3′	3024	5	3024	
	4′	5470	7	5470	
	5′	14112	33	14112	
1/1	1′	933	27	933	
	2′	2700	20	2632	Mean 2736. From expt. 21, 3516, it is deduced that small surfaces (1 sq. ft.) give results $\frac{1}{4\cdot7}$ greater than large surfaces (3 sq. ft.).
			22	2822	
			23	2755	
	3′	4400	28	4400	
	4′	8000	29	9400	Reduced by $\frac{1}{4\cdot7}$ to 8000.
	5′	22000	30	27552	Mean 28056.
			31	28560	Reduced by $\frac{1}{4\cdot7}$ to 22000.
1/2	1′ 6″	2100	18	2350	Reason of difference in tabular value not known.
	2′	3880	25	3882	
1/3	2′	4032	24	4032	
1/4	2′	4370	26	4368	
	4′	12260	—	—	Cannot be traced.

Digitized by Google

IMPROVISED DRAWBRIDGE.

By MAJOR C. S. WILSON, R.E.

THE following particulars of an improvised drawbridge may be of interest to the Corps in general, as the writer has not seen this principle applied to an improvised bridge before.

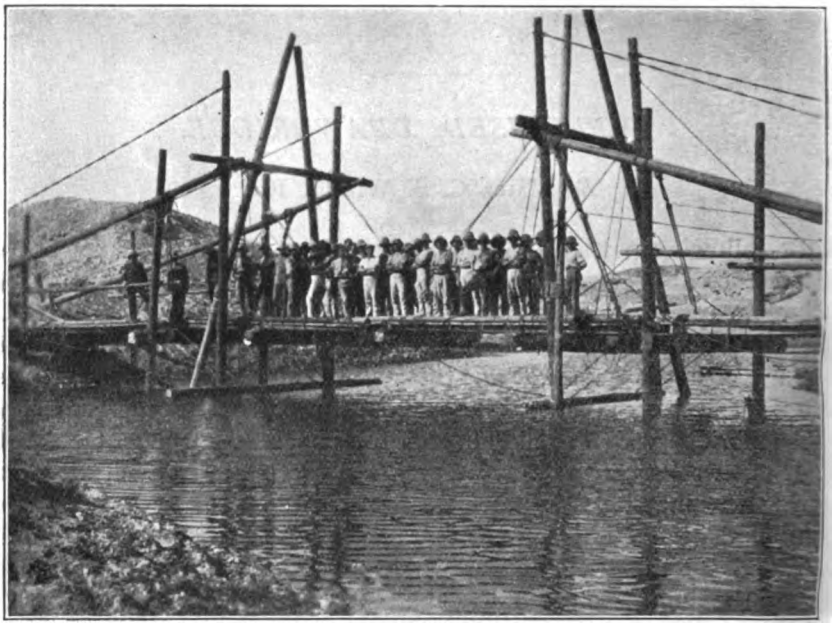
As in Egypt there are several canals along which a considerable volume of traffic travels, it was thought we might very possibly, in the event of active operations, be called upon to construct over one of these a bridge which would allow of traffic passing through it. Lieut. J. K. Dawson-Scott was accordingly asked to design such a bridge during the individual training season. Owing to his leaving the command he did not construct it, but his design was gone over and modified by Lieut. A. H. Brown, who afterwards built the bridge during the annual course of the 2nd (Field) Company. The idea was taken from Sir John Ardagh's bridge as shown in *Structural Design*, Part II.

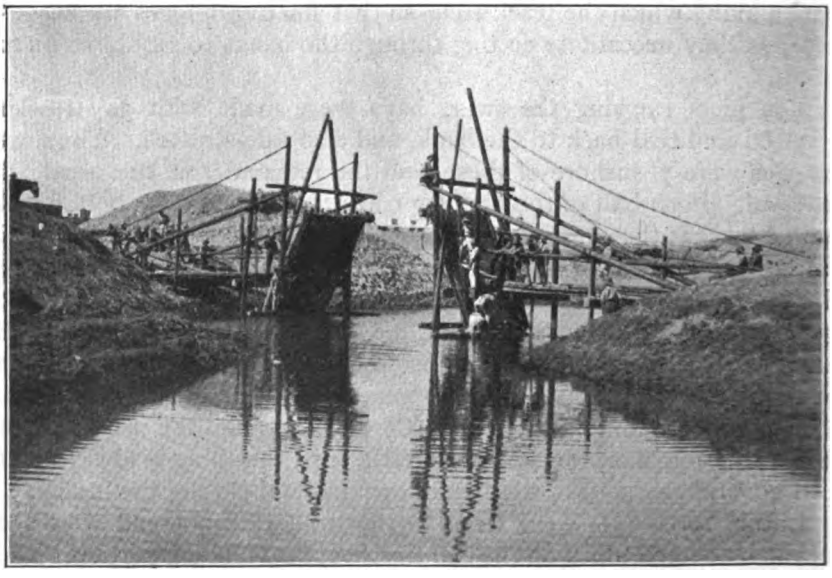
The necessary opening was taken as 30′, which is ample to allow of the native boats (ghyassas) passing, and the total span was 100′, or about the same as most of the canals. These generally have high banks along which the track runs, so that floating bridges are unsuitable, as they necessitate cutting through the banks to get down on to them.

The piers carrying the swing bays were made with 30′ trestles strutted and tied back to the bank, and also side-strutted. The next trestles were 7′ inshore of these, and the remainder at the usual 15′ interval. Each half of the opening consisted of a 19′ bay, bolted and nailed, so that the superstructure would not slip off when the bay was raised. A transom was fixed just inshore of the centre of gravity of the bay, a sling (A) from this to the top of the trestle carrying the weight of the bay when in motion, and also part of the load when the bridge was closed. The front transom had also a sling (B) to the top of the trestle, which only took the weight when the bridge was closed. The pivot was formed by a sling (C) passing round the rear transom and a transom fixed outside the trestle legs, this sling is always taut and governs the path of the bay in opening and closing the bridge.

Lifting ropes (D) were fixed to the front transom, and were led through a snatch block on the end trestle of the standing portion. The best lead was found to be just above the top of the swing bay when the bridge was open, as the pull got heavier as the bay was raised.

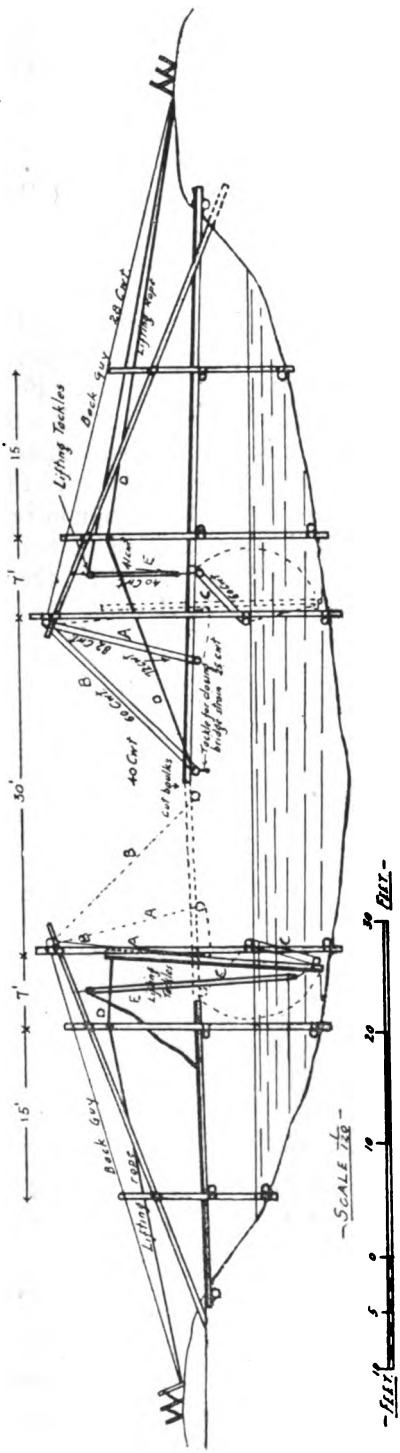
Digitized by Google





Digitized by Google

DRAWBRIDGE FOR INFANTRY IN FOURS.



Strains calculated graphically for infantry in fours. Slings and guy of ¾" steel wire rope. The lifting can be done by four men on each side. The shore ends of drawbridge fit when the centre is pulled together by the closing tackles and cut baulks are provided for the centre.

Wood chocks are provided to drop between drawbridge and frame to prevent side swaying.

Digitized by Google

Lifting tackles (E) were fixed to the rear transom for closing the bridge; these tackles also part took of the weight when the bridge was closed. Short cut-baulks were provided in the centre, and the two swing bays finally pulled together by tackles which hooked on to pins in the ends of the front transoms, and took off some of the strain from the pivot sling when the bridge was fully loaded.

The plan and photographs show the bridge clearly. The stresses were worked out graphically and are quite simple.

The swing part was very stiff and steady longitudinally, but when tested by marching over it in fours developed a nasty sharp swing sideways. This was remedied by providing wooden chocks to drop in between the sides of the swing bay and the trestle legs, after which the bridge was quite steady and satisfactory. Four men on each side could work the bridge easily and it only took a few minutes to open and shut. It took rather a long time making, as it was quite new to all of us, and a bad bottom gave trouble with the trestle legs, but I think it could easily be done again by 30 men in 15 hours. The points that require careful watching are the correct length of the slings and the correct placing of the trestles. Altogether it formed a very successful bridge for the purpose in view.

Digitized by Google

NOTES ON THE PANAMA CANAL.

By LIEUT. R. A. OWEN, R.E.

HISTORICAL.

IN 1876, certain Frenchmen directed their attention to the possibility of cutting a canal through the Isthmus of Panama; the site between Colon and Panama being selected as the best.

In 1878, a concession was obtained from the Columbian Government, and in 1879-80, the Panama Canal Company, with De Lesseps as its President, was floated.

The original plan, to cut a sea-level canal, was soon altered, as it became apparent that a tidal lock was a necessity, since the rise and fall of tide above and below mean sea level is about 9″ on the Atlantic side and about 10′ on the Pacific. Later the damage done by the sudden floods of the Chagres River led to the proposal that a dam should be made for their control; and finally in 1887, it was decided that a lock type canal was most suitable and economical.

Two years later, in 1889, the Company became bankrupt.

In 1894, the new Panama Company resumed the work and continued until 1904, when the United States Government took over all canal works and properties on the isthmus.

The amount of work done by the French companies is greater than is generally supposed, and it is found that all subsidiary work, such as survey, is excellent, and is of great use to the American engineers who now have the canal in hand. The profile (*Fig.* 1, see *Plates*) shows the amount of excavation done by the French, and the amount done and remaining to be done by the Americans.

Even the present scheme, a lock canal with a dam at Gatun, was originally advanced by the French (in 1879) but was subsequently discarded.

ADMINISTRATION AND ORGANIZATION.

The administration of the whole area of the canal zone, *i.e.* of the strip of land 5 miles wide on each side of the canal taken over by the United States from the Republic of Panama, is under the Isthmian Canal Commission.

The Commission consists of a chairman (Colonel Geo. W. Goethals, Corps of Engineers United States Army), six members, and a secretary. Of the members, three are from the Corps of Engineers, one from the Medical Corps, one civil engineer from the United States Navy, and one civilian, head of the Department of Civil Administration.

Digitized by Google

The administration is carried out under six departments, as follows: —

(1). Department of Construction and Engineering.
(2). Quartermaster's Department.
(3). Subsistence Department.
(4). Department of Civil Administration.
(5). Department of Law.
(6). Department of Sanitation.

The Department of Construction and Engineering is controlled directly by Colonel Goethals as Chief Engineer of the Commission.

As far as construction and engineering for the canal are concerned the department has three construction divisions—Atlantic, Central and Pacific—each under a division engineer.

In addition, the office of Chief Engineer is subdivided into three divisions. The first division deals with designs, contracts, etc.; the second with maintenance of plant, machines, shops, supervision of expenditure, allotment of work, etc; the third with survey, meteorology, and hydrography.

The Quartermaster's Department deals with *personnel*, labour, quarters, transport, construction of buildings, material and supplies.

The Subsistence Department deals with the subsistence of the Commission employees generally. This department manages all restaurants, hotels, and labourers' messes in the zone, and provides all supplies for both single and married employees.

The Departments of Civil Administration and Law deal with all such matters as obviously come within their scope. Such are:—posts, customs, taxes, police and prisons, schools, courts, legislation, adjustment of claims, etc.

The Department of Sanitation deals with all medical, surgical, sanitary and quarantine services.

In addition to the six departments there is an Examiner of Accounts, a Purchasing Officer (in Washington), and a Disbursing Officer, each with a large staff.

The Secretary of the Commission has charge of all canal records and investigations of complaints, in addition to the Isthmian Canal Commission band of 43 performers.

General Description.

Starting from the Atlantic there is to be a channel, 500′ wide and 41′ deep, from deep water in Limon Bay to Gatun. This channel runs north to south in direction, the general direction of the canal being N.W. to S.E. From Limon Bay to Gatun is approximately 7 miles.

At Gatun are situated the flight of three twin locks to raise ships from sea level to the canal level 85′ higher. In addition to the locks it has been necessary to construct a dam at this point, 8,000′ in

Digitized by Google

length, 1,500 to 2,000′ thick at base, and 115′ high. This dam will form an artificial lake, Gatun Lake, through which ships will pass in a channel from 500 to 1,000′ wide. The area of the lake will be approximately 160 square miles. The ship channel has of necessity certain bends in it as the accompanying plan shows (*Fig.* 2, see *Plate*).

The full depth of water in this channel will be 45′ to allow a small margin for dry seasons. After about 23 miles of this lake, Bas Obispo is reached, and here the Culebra Cut begins. The Culebra Cut extends for 9 miles, *i.e.* as far as Pedro Miguel and through it the channel is 300′ wide. The amount of excavation for the cut is shown in the section—the bottom of the cut being at an elevation of 40′ above sea level, and the highest point at the sides 534′, and of the original centre line 312′, above sea level.

At Pedro Miguel, a single twin lock lowers ships 30′ to a small lake whose surface is 55′ above sea level. Through this lake a channel, about 1 mile long and 500′ wide, with 45′ depth, leads to Miraflores. At Miraflores two twin locks will lower ships to sea level on the Pacific side. From Miraflores a channel 500′ wide, 45′ deep and about 8 miles long, leads to deep water in Panama Bay.

It will be seen that the canal, once the exact site was settled, offered the following main problems to the engineers :—

(1). The locks at Gatun, Pedro Miguel and Miraflores.
(2). The Gatun Dam and Lake.
(3). The Culebra Cut.

The channels to deep water at each end and the smaller dam at Miraflores call for no special notice when compared with the more striking features.

Locks.

The design of all locks is similar and it will therefore be sufficient to describe only those at Gatun. These consist of three twin locks of concrete, each 1,000′ in length and 110′ in breadth with a 60′ dividing wall between (*Fig.* 3, see *Plate*). Double gates are provided at the ends, and in each lock a subsidiary gate is placed about two-thirds along its length as a safety device, and to permit of economy of water when passing small vessels. At each end of the flight the dividing wall is continued for about 1,000′ and will be used for ships to tie up to before entering the lock. In each lock the rise and fall of water is 28·3′ and this with a 41′ minimum depth of water gives a minimum height of wall of approximately 70′. The actual height is a few feet more.

Some little difficulty has been found at Gatun in obtaining satisfactory foundations. At one point it was necessary to excavate to 66′ below sea level, whilst the south middle wall is being built on piles for a considerable portion of its length. The remainder of the structure rests on solid rock.

Digitized by Google

The gates consist of steel frames with steel plates riveted on both sides, and pivot on two hinges only.

The water is to be run to and from each lock through circular channels, of 18′ diameter, in the side and centre walls. Circular holes in the floor of the lock communicate with these channels, and as these holes are very numerous, about 110 in each lock, and regularly spaced over the floor, the filling and emptying should be smoothly effected.

Along the tops of the centre and side walls will be laid rails, on which tractors will run to handle ships through the locks. These tractors and all machinery in connection with the working of the locks will be electrically operated, and the machinery for operating gates and valves will be placed in recesses in the centre wall.

The mode of procedure in handling a ship through the locks will be as follows :—The ship will come up under its own motive power to the extension of the centre wall, and there tie up. It will then be taken in hand by four tractors, two towing in front, and two behind ready to slow the ship as necessary. These tractors will control the ship through all three locks, at a rate of not more than 2 miles an hour, and not until the ship is clear of the last lock will her own motive power again be used. Each tractor will weigh over 30 tons, and its electric motors will operate gears which will engage a rack rail on the track.

Hawsers from the ship will be attached to windlasses on the tractors. These windlasses will be provided with friction clutches to slip at a strain of 25,000 lbs., thus allowing for a certain amount of elasticity in the pull.

SAFETY DEVICES.

The most likely cause of damage to the locks is a ship not under proper control ramming the end gates. To prevent this, extra gates are provided at each end as already stated. In addition, a special chain fender has been designed and will be fitted about 500′ above and 230′ below the upper and lower gates respectively. When not in use, these chains will rest in grooves in the floor and side walls of the locks. When in use they will be raised to the surface of the water forming a barrier to the passage of ships. Such resistance will be provided by hydraulic cylinders at each end of the chain, as will absorb the energy of a ship of 10,000 tons moving at 4 miles an hour before it strikes the lock gate.

In addition floating caisson gates will be provided for use in front of the upper gates in case of emergency. These caissons will also be of use in permitting examination and repairs to gates below them.

For the operation of all valves, gates, etc., an electric plant, to be operated by water power, is to be installed at Gatun, with a reserve plant at Miraflores to be operated by steam. Transmission lines will communicate throughout, and current from either or both can be used for any part of the canal.

Digitized by Google

Gatun Dam and Lake.

The Gatun Dam, with its lake, is in some respects the most interesting feature of the canal. Certainly the people of Cristobal and Colon, towns below, must feel that here lies the most important work on the isthmus.

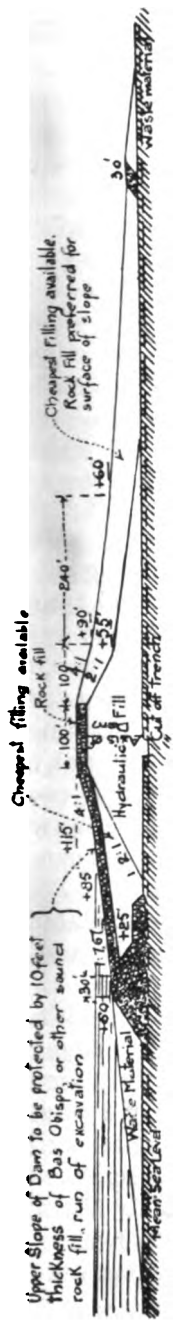

Cheapest filling available.
Rock fill
Hydraulic Fill
Cheapest filling available. Rock Fill preserved for surface of slope
Upper Slope of Dam to be protected by 10 feet thickness of Bas Obispo or other sound rock fill, run of excavation
Waste material
Mean Sea Level

Fig. 4.—*Cross Section of Gatun Dam.*

The section (*Fig.* 4) shows the main dimensions of the dam at its widest point. The central portion consists of a hydraulic fill held in place by a fill of the cheapest material available. The outside of the dam on the south side is protected by a 10′ thickness of sound rock fill. The hydraulic fill is obtained from the bed of the Chagres River and is pumped in a semi-liquid state (80 per cent. water) into the dam by special dredges. The water drains and evaporates away leaving the hydraulic fill in place. At the present time this hydraulic fill is almost completed. The material to form the fill to hold the hydraulic fill in place is brought down by trains mostly from the Culebra Cut. The rock for the protecting wall comes mostly from Bas Obispo.

Elaborate boring operations have been carried out on and near the site of the dam to determine the soundness and impermeability of the underlying strata, and it has been proved that there is no appreciable flow of water below the surface near the site of the dam.

The Spillway is situated nearly in the centre of the dam. Its plan forms a segment of a circle, radius of crest 314·6′, radius of toe 221·6′, distance between abutments 312·9′. It is of ogee section, with a height of 69′ above sea level at the top of the concrete work and 10′ above sea level at the toe. The steel gates controlling the water above 69′ are arranged between 13 concrete piers.

The apron extends about 960′ north of the dam and consists of concrete on rock, the concrete being 4′ thick near the dam and 1′ thick at the toe of the apron. The width of the Spillway Channel is 285′.

Culebra Cut.

The Culebra Cut is 9 miles long across the highest part of the isthmus. Its width at the

Digitized by Google

bottom is 300′, and lowest depth 40′ above sea level. The section (*Fig.* 5) shows the cut at Culebra which is at its widest point, and illustrates the state of the excavation work on 1st November, 1911.

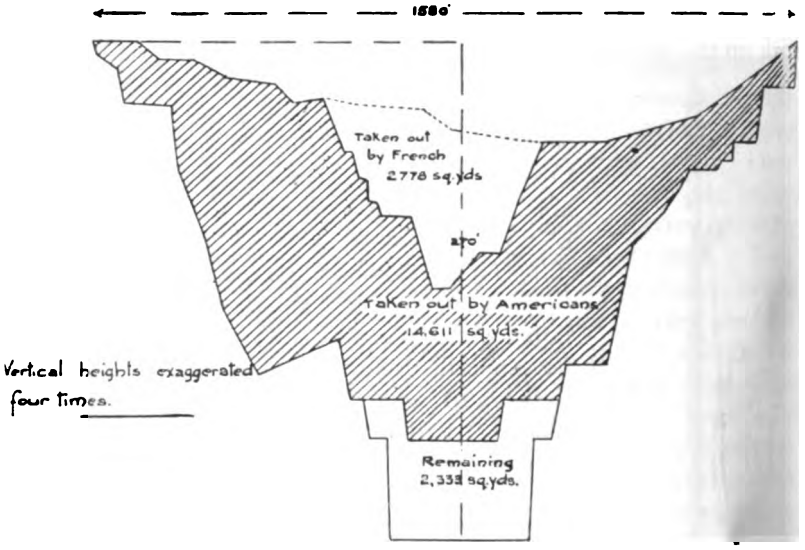


FIG. 5.—*Cross Section of the Culebra Cut at Culebra where the trench is at its greatest width.—1st November*, 1911.

It was here that the French did most of their work, taking out in all some 20,847,000 cubic yards of material between 1881 and 1904.

Since 1904 the Americans have removed about 85,000,000 cubic yards. In each of the years 1909, 1910 and 1911 close upon 20,000,000 cubic yards were removed. This great increase is due in a large measure no doubt to the improved and more plentiful machinery of the Americans. But besides this the nature of the material has changed; the French had to contend with a sticky clay that could not be dropped from the shovels and that would not carry a railway track; the Americans have to deal with a harder material that can be more easily handled.

The organization of the excavation work and handling of material to and from the dumps is most perfect, and no delay is allowed to occur.

The work of excavation in the Culebra Cut is done almost entirely by steam shovels, working after a blasting party. Small charges of dynamite are exploded to loosen the soil or rock sufficiently for the steam shovel to be able to work. A very large quantity of dynamite is used throughout the canal (400,000 lbs. per month) and a certain amount of difficulty has been experienced with it. Such surprises as may be expected to result from free nitroglycerine, quickly liberated by a slight acidity of the underground water, are not unknown.

The chief point that has attracted attention to the Culebra Cut has

Digitized by Google

been the difficulty experienced with land slides. These slides are of three kinds: firstly, those due to the slope of excavation being left steeper than the material will assume in its natural state. These give but little trouble, as the amount of material to be handled is small and when sufficient has slid and been removed the surface reaches its natural slope and all movement ceases. Secondly, slides occur when layers of clay overlie smooth layers of harder material sloping towards the centre of the canal. These slides are more troublesome than the first as the amount of material is often large and tracks are upturned thereby. So far the only means of combating them has been by excavating all material as it entered the cut. Experience has shown that it is only a question of time before they cease entirely.

Thirdly, breaks have occurred, especially at Culebra itself. These breaks are likely to take place where ever the underlying rock is of poor quality. As the excavation proceeds the distribution of weight is changed, until the breaking point of the weak stratum is reached and the rock is broken up and squeezed out of place, either heaving up the bottom of the cut or pushing out the side slopes.

The method of dealing with these breaks, is to try to relieve the pressure by cutting benches along the walls of the canal. This treatment has proved very successful. It is also to be observed that when the water is let in, support will be given to the weak strata of rock and greater stability may be expected.

The reports current as to the gravity of these slides are greatly exaggerated, and no one of the isthmus appears to have any misgivings as to the entire success of the cut at an early date. The two largest slides of the last year have been at Cucaracha and Culebra, covering 47·1 and 46·6 acres respectively.

Other possible causes of damage to the canal are flood and earthquake.

The former danger is entirely removed by the construction of the Gatun Lake. In the early days much damage was caused by the Chagres River, which is liable to very sudden floods. Now, however, the great volume of water impounded in the Gatun Lake will not be appreciably affected by the largest flood on the Chagres.

As to earthquake; this region is supposed to be very liable to earthquake, but no records exist of any serious damage from this cause and the stranger in Panama is shown the ruins of a church destroyed by fire, amongst which can be seen standing an elongated flat arch of about 40′ span which certainly could not have withstood any serious earth-tremor. As the church is over 200 years old we have proof that the region has suffered no dangerous earthquake for that time.

Digitized by Google

SANITATION AND SUBSISTENCE.

The main work of the Americans during the first 2½ years of their occupation of the canal zone was the rendering of the whole area healthy by methodical sanitation. In 1904 the total force employed was slightly more than 6,000 with a death rate of 13·3 per thousand. This low death rate was due, not to absence of disease of all sorts, but to the immunity of the population, who had gained this immunity through years of exposure to infection and weeding out.

On increasing the size of the force a large non-immune population was introduced, and, in 1906–7 with a working force of 32,314 the death rate was as high as 39·3 per thousand. From this date, under the improved sanitary conditions, the death rate dropped until in 1910–11, with 49,129 employees, the death rate per thousand was 11·34.

The same drop in the death rate is seen when we consider the total population of the isthmus, Panamans as well as Commission employees. In 1906–7 with an average population of 87,215 the death rate per thousand was 42·08, in 1910–11 with a total population of 154,255 the death rate was 22·10.

It is interesting to note that deaths amongst employees from malaria in 1906–7 numbered 205, and in 1910–11, 41, and this with an increase in total numbers of about 50 per cent. for the latter year.

These results have been obtained by the elaborate sanitary measures in operation throughout the whole area.

Take for instance mosquito destruction :—All surface water is collected in open channels as far as possible, and at the head of each channel is a drip vessel containing crude oil, which drips at a rate sufficient to thoroughly oil its own section of channel. Near any settlements these channels are usually concreted to avoid any chance of hidden unoiled pools forming. All streams are kept clear of weed and their banks of vegetation; reservoirs are stocked with fish, and bush and high grass cleared in a wide belt around houses. In the dry season the main streams and rivers become almost stagnant in places, and require oiling in addition to the smaller streams and pools. Every house used as a dwelling is thoroughly screened with wire gauze which is periodically inspected and kept in good repair; many of these houses are old French buildings which, though without roof ventilation, are entirely suitable to the climate. A noticeable point about all buildings on the zone, is that the predominant colours for outside painting of walls and roofs are dark grey and black; even the roads are dark. These colours look gloomy to the newcomer, but after a time he appreciates the rest they give to his eyes. This is very different from the colours of buildings in many tropical places where the blaze of light and colour at midday is unbearable. An elaborate system of charts is in opera-

Digitized by Google

tion, by means of which cases of disease are plotted in the head office and the location of any source of infection is immediately shown up.

The purity of the water supply has been carefully preserved. Catchment areas are regularly patrolled and are guarded from trespassers. Periodical analysis of water is carried out and distilled water is delivered by the Commission to its employees. Sewage disposal also is carefully planned and carried out.

The sick are provided for in two main hospitals at Ancon and Colon, with subsidiaries at each settlement. A hospital car goes through the line daily to take patients to the main hospital. A sanitorium for convalescents has been established on Taboga Island, about 9 miles out to sea from Panama. Medical treatment is free to all employees.

A great factor in preserving the health of the negro population has been the establishment of labourers' messes under the Subsistence Department. This system has compelled the negro to spend a portion of his earnings on good food instead of, as he prefers to do, saving money on food to spend it on personal adornment. A well-fed, and therefore healthy, negro without patent leather boots, is found to be more useful as a labourer than one who has half starved himself in order to purchase the latest thing in footwear.

The Subsistence Department operates, in addition to 30 labourers' messes, the Tivoli Hotel at Ancon, 19 line hotels, and three night restaurants, besides providing all supplies for employees who do not make use of the messes or hotels. The total number of persons catered for being upwards of 60,000. The department has a gross revenue of about 1¼,000,000 dollars and a profit of some 60,000 dollars.

Boats arrive from the United States at intervals of five days with supplies sufficient for five days' consumption. These are stored into a large cold storage warehouse at Cristobal (Colon), where a reserve store of about 14 days' supplies is held in case of the non-arrival of any ship. In addition to the cold storage warehouse, there is at Cristobal, under the control of the Subsistence Department, a laundry and bakery which provide for the needs of the whole zone.

Only the most modern machinery is installed, and the most scrupulous cleanliness is observed throughout. One is shown a dough-mixing machine doing the work of 69 bakers, and other elaborate machinery such as collar and shirt pressers, coffee roasters, beef mincers, etc., etc. In dealing with food stuffs great care is taken to avoid all unnecessary handling, and each class of supply is stored by itself. For instance one store is allotted to carcases, another to butter, a third to vegetables, and so on.

Only the highest qualities are purchased, and the contractors are kept up to the mark by careful inspection. For instance every egg,

Digitized by Google

of which about 40,000 are issued daily, is carefully examined before it leaves the store, and very few complaints as to quality are received.

Those employees who do not make use of the messes are allowed to send in written orders for goods to the Cristobal Office, and each day a train goes through the zone distributing the supplies ordered, and replenishing those at the hotels and messes.

A system of coupons is in use at the messes by which an employee may draw a part of his pay in a meal coupon book; each coupon being good for meals at the particular class of mess which caters for the individual concerned. In the case of "gold" employees the cost of a coupon is 30 cents and is good for one meal. For white labourers who receive 20 cents an hour working pay, the cost of the coupon, good for three meals, is 40 cents; for coloured labourers, who receive 10 cents an hour, the cost of the coupon, good for three meals, is 27 cents. The meals provided are such as are considered suitable for the class of employee using the mess.

DATE OF COMPLETION.

The original estimate of time required for completion fixed the opening date as January 1st, 1915. The work has advanced so rapidly, however, that it has been found that the canal will be ready about 18 months earlier than this. The Gatun locks will be completed, as far as concrete work is concerned, in June, 1912, and the Pedro Miguel and Miraflores locks in the following October. The gates and operating machinery for all locks should be in place by June, 1913, when the locks will be ready for operation. The Gatun Dam will probably be completed early in 1913, and the Culebra Cut in July, 1913, if no serious slides occur beyond those estimated for. By the latter date the exterior channels to deep water will be sufficiently advanced to pass shipping, so that in all probability the canal will be near enough to completion, for operation by July, 1913.

The official opening may take place a month or two later.

In conclusion the writer wishes to express his thanks to Colonel Goethals who kindly placed at his disposal means for collecting the information contained in this article.

Digitized by Google

HISTORICAL DOCUMENTS OF MAJOR-GENERAL SIR J. T. JONES, BART., K.C.B., R.E.

(*Continued*).

The following notes on the Artillery operations against Olivença, Ciudad Rodrigo and Badajos, were prepared by Sir A. Dickson, K.C.B., R.A. for Sir J. T. Jones when the latter was preparing his history of the Peninsular War.

Operation against Olivença.

1811.—*April 9th.*—Marshal Beresford advanced from the Guadiana and invested Olivença. When the Marshal reconnoitred the place, Major Dickson pointed out an inclosed Lunette in front of the gate of San Francisco, from which he knew by a former visit to Olivença, the curtain could be battered in breach. Immediately after this examination, the Marshal dispatched Major Dickson to Elvas, to bring forward the heavy Ordnance required for the Siege, and he reached Elvas the same night.

10th.—Six heavy Brass 24 Prs., with heavy travelling Carriages, 300 Rounds per Gun, and all other requisite Stores were got ready, as also Block Carriages for Conveying the Guns.

The exertions of Lieut. Sabugal belonging to the Portuguese Arsenal at Elvas, were very distinguished in this preparation. 104 Pair of Bullocks required for moving the equipment.

Major Dickson sent off the following Engineer Stores to Captain Squire, loaded on 24 mules :—6,000 Sand Bags, 130 Shovels, 35 Spades, 60 Picks.

Three Petards prepared to accompany the train of Artillery in Consequence of an order received from the Marshal this day.

11th.—The equipment detained till the latter part of the day waiting for Bullocks.

A Portuguese Company of Artillery, consisting of 100 Officers and men of the 3rd Regt., under the Command of Captain Jose de San Payo, attached to the equipment.

It advanced about a league on the road to Jerumenha this Evening.

12th.—The heavy Artillery proceeded this day to Jerumenha and crossed the river, the Petards by an order received from the Marshal were left at Jerumenha.

13th.—This morning the heavy Artillery arrived at the Camp before Olivença, and immediately proceeded to the Neighbourhood of the point of attack.

The breaching battery for four 24 Prs. being in readiness, an attempt was made this night to put the Guns in battery, but it was found impossible to effect it, from the badness of the road, and the Circuit the Guns were Obliged to take.

Digitized by Google

14*th.*—The Communications having been made practicable this Evening, the four Guns were moved into the breaching battery with all the necessary Ammn. and Stores in readiness for opening in the morning. The old magazine of the Lunette answered admirably for the Security of the Ammunition.

Two batteries for the Field pieces of the German Artillery were also established, to keep the fire of the Enemy in check.

Breaching Battery.—4 Brass 24 Pounders.

Supporting Batteries.—3 Field pieces viz.—1 5½ Inch Howr., 2 6 Prs.; 3 field pieces, 6 Pounders.

15*th.*—The Breaching battery opened its fire against the Curtain to the left of the San Francisco gate at 8 a.m., and the fire was continued without intermission till 11, the distance being about 340 yards; the Enemy at that hour showed a flag of truce, which occasioned a suspension, after which the fire was resumed for a few rounds, and then they surrendered at discretion.

The Portuguese Artillery though mostly Young Soldiers, showed a good spirit in this operation, the fire was well directed, and not a Shot was thrown away, which is best proved by the result, for the breach was nearly practicable in 4 hours by the expenditure of 320 Rounds.

A brisk fire from five or six Guns, and a good deal of Musquetry, was kept up by the Enemy against the breaching battery, and the Portuguese Artillery had two men killed, and six wounded.

The Field pieces of the German Artillery materially assisted in drawing the attention of the Enemy during the attack.

Expenditure of Ammn.—Battering Guns, 80 Rounds each; Field pieces, 60 Rounds each.

Cadet Francisco Joze Franco of the 3rd Regt. of Artillery, was promoted to 2nd Lieut. for good Conduct on this Occasion.

Ordnance Captured.

Ordnance Mounted	Brass	8 Prs. ...	...	1
		4 Prs. ...	...	2
	Iron	12 Prs. ...	...	5
		8 Prs. ...	...	2
		6 Prs. ...	...	2
Ordnance Dismounted	Brass 8 Prs.	...	...	1
	Iron 12 Prs.	...	...	2
			Total	15

The Iron Guns which the French had found laying on the works without Carriages, were very ingeniously mounted by them on Strong Bullock Cars, by the addition of Frame work, and a block under the pole, which rendered them very manageable, as temporary Gun Carriages.

A.D.

Digitized by Google

Preparations for the Siege of Ciudad Rodrigo.

1811.—*July 19th.*—This day Lord Wellington assembled the following Officers, at His Head Quarters The Quinta de St. Joaó, near Elvas:—Lieut.-Colonel Framingham, C.R.A.; Lieut.-Colonel Fletcher, C.R.E.; Mr. Kennedy, Commissary Genl.; Major Dickson, Comg. Portuguese Reserve Artillery.

His Lordship informed these Officers that it was his intention to undertake the Siege of Cuidad Rodrigo, that he had ordered Fourteen Sail of transports with an English Battering train on Board round from Lisbon to Oporto, and that he wished Major Dickson to proceed to Oporto by way of Almeida, to take the direction of the Conveyance of the train up the Douro to Lamego, and from thence by land to Trancoso, where the equipment would assemble in the first place.

The train in question was as follows:—

			Rounds per Gun Grape Case, &c., included.
	24 Prs. Iron... ...	34	644
	18 Prs. Do.	4	440
	10 Inch Mortars Do.	8	525
Brass	5½ Inch Do.... ...	10	348
Brass	8 Inch Howrs. ...	2	215
	5½ Inch Howrs. Iron	20	348
	Total	78	

From this equipment Lord Wellington made the following Selection of Ordnance to be employed—

24 Prs. Iron	34
18 Prs. Do.	4
10 Inch Mortars Do.	8
8 Inch Howrs. Brass	2
	43

The Calculation was first made on the 20 iron 5½ Inch Howrs. were 48 pieces, but by a Subsequent Order, added, making 68 pieces in all, and by appropriating the 5½ Inch Mortar ammn. to these Howrs., they were compleated to 520 Rounds each.

An Estimate having been made of the land transport required for 48 pieces of Ordnance, allowing 8 pairs of Bullocks for each, and also for the Conveyance of the necessary Stores, and the proportion of ammn. required for two days firing, at the rate of 175 Rounds a Gun, and 80 Rounds for each Mortar and Howr. per diem, the following was the result:—

	Pairs of draught Bullocks.	Bullock Cars.
For Ordnance, Spare Carriages, Forges, &c.	381	—
For Powder	—	171
For 24 Pr. Shot	—	396
For 18 Pr. Do.	—	35
For 10 Inch and 8 Inch Shells	—	200
For Laboratory and General Stores, &c. ...	—	90
Total	381	892

Digitized by Google

In addition to the foregoing there were required 200 Bullock Cars for the Engineer Stores.

There being a deficiency of powder in the equipment, Lord Wellington desired Col. Framingham to order 1,600 Barrels from Lisbon to compleat the train at Oporto, and he also directed that Two Companies of British Artillery should be immediately ordered to Oporto by Sea, there to be placed at the disposal of Major Dickson.

These points having been Settled, Lord Wellington drew up the following memorandum of instructions for the guidance of those Concerned :—

Memorandum.

19*th July*, 1811.

1*st*.—The Heavy Ordnance and Stores, and Engineer Stores now embarked in the Transports in the Douro, being required at Cuidad Rodrigo, measures must be adopted to remove them thither.

2*nd*.—They must be removed into Boats at Oporto and carried by water to Lamego.

3*rd*.—At Lamego they must be landed and the Ordnance removed at Once by 384 pairs of Bullocks to Trancoso. The Stores that is to say 350 Rounds for each 18 Pr. and 24 Pr. Gun, and 160 Rounds for each 10 Inch Mortar, &c., to be removed there on 892 Country Carts.

4*th*.—The Engineer Stores to be removed to Trancoso upon 200 Country Carts.

5*th*.—The 892 Carts mentioned in No. 3 to be unloaded at Trancoso, and to return to Lamego to bring up to Trancoso the remainder of the Stores.

6*th*.—Upon the Arrival of the Second quantity of Stores at Trancoso, the whole Ordnance, and the Stores for 350 Rounds a Gun and for 160 Rounds each Mortar, &c., in 892 Carts, and the Engineers Stores in 200 Carts, to move to Cuidad Rodrigo.

7*th*.—The Ordnance Stores to be unloaded at Cuidad Rodrigo, and the 892 Carts to return to Trancoso for the Second Convoy.

8*th*.—Colonel Framingham to order from Lisbon to Oporto 1,600 Barrels of Powder to Compleat the quantity at that place to what will be Sufficient with the Battering train.

9*th*.—Major Dickson is requested to proceed to Oporto, in order to Superintend the removal of the Ordnance and Stores from thence, and Colonel Fletcher will send there an Officer of the Engineer Department.

10*th*.—These Officers will Communicate with the Gentlemen employed by the Commissary General, to collect the necessary boats and Carts, and the matter should be Arranged in such a manner, as that the Stores could be at Lamego, at the same time the Carts would be ready to remove them.

11*th*.—The two Companies of British Artillery now at Lisbon to be ordered to Oporto by sea.

Digitized by Google

12*th*.—Probable time these operations will take :—

12 days for Major Dickson's Journey to Oporto.
6 days for the removal of the Ordnance and Stores to the Boats.
6 days from Oporto to Lamego.—(Pezo de Regoa).
8 Days landing Stores from Boats, and moving up the Hill to Lamego.
4 Days from Lamego to Trancoso.
4 Days Carts to return and load.
4 Days Second trip to Trancoso.
6 Days to Cuidad Rodrigo.
6 Days to return to Trancoso.
6 Days to bring Second quantity of Stores to Cuidad Rodrigo.

Total 62 Days.

(Signed) WELLINGTON.

The Object of Major Dickson visiting Almeida on his way to Oporto, was to examine the Shot and Shells remaining at that place, to see if there was any quantity available for the Service in View, particularly 24 and 18 Pr. Shot, of which there was a deficiency in quantity with the train. A further object for his proceeding by this route was to examine the passages of the Coa at the Bridge of Almeida, and the ford of Porto de Vide on the Northern side of the Serra de Marofa, and afterwards to inspect the roads from thence to Trancoso and Lamego.

Orders were immediately sent off to Lisbon, for Major Bredins and Captain Glubbs Companies of the Royl. Artillery being sent round to Oporto, and directions were transmitted at the same time for 1,600 Barrels of powder being forwarded there.

21 *July*.—28*th*.—Major Dickson Commenced his Journey this day, and he reached Almeida on the 28th though detained two days on the road by a Severe intermittent fever.

He found Almeida without any garrison, and every thing in the greatest Confusion in the place, from the double destruction it had undergone, there were 197 pieces of ordnance either spiked and Unserviceable, 155 Gun Carriages and mortar beds, and a quantity of Tumbrels, Limbers, Forges, and other Stores but all in a most dilapidated state.

The quantity of projectiles was very considerable, but much Scattered and mixed. He found however a compleat pile of 3,760 Spanish 16 Pr. shot, which would answer tolerably well for the British 18 Pr., and there being a proportion of 24 Pr. Shot that would answer mixed with the others, the Acting Governor, Lt.-Col. Joaó Nepomuceno Reboxo, undertook to have them Guaged and Seperated, and to Communicate the results ; as Major Dickson could not wait such an investigation.

July 29*th*.—Major Dickson continued his journey by Porto de Vide, Trancoso, and from thence to Lamego, at which place he arrived early on the morning of the 1st August.

Digitized by Google

Lamego, Augst. 1st.—He immediately proceeded to Mr. Assistant Commissary General Boyes, and having arranged with him respecting the preparation of Transport, he waited on Genl. Bacellar, the Governor of the Province, and after explaining the nature of the duty to be performed, he requested of His Excellency that the roads from Lamego to Almeida, by Cotimos and Pinhel, and also by Trancoso, might be repaired. He further requested that 1,000 Militia might be in readiness to escort and assist the train on its march. General Bacellar promised to take immediate measures to provide for these Objects in an efficient manner.

Major Dickson then wrote to Lord Wellington, that the route by Trancoso was very mountainous and difficult, and that there were a number of passes so steep and rocky, as to require a length of time to make them practicable for heavy Artillery, for which reason he begged to propose the train should proceed by the route of Villa da Ponte, Torrinha, Cotimos, and Pinhel, and that one of the first of these places should be chosen as the station of deposit, instead of Trancoso.

Oporto, Augst. 3rd.—Major Dickson having made these Arrangements he embarked in a light Boat on the Douro at Pezo de Regoa early on the morning of the 2nd August, and arrived at Oporto on the morning of August 3rd, at which place he found the two Companies of Royal Artillery (Bredins and Glubbs) just arrived from Lisbon—the latter under the command of Capt. Power.

Mr. Assistant Commissary General Mackenzie was using every endeavour to procure Boats, but although an embargo was laid on the river to facilitate the Object, he had found great difficulty in Obtaining them from the lowness of the river, and the consequent impossibility for the largest description of boats to navigate when loaded, over the Shallows between Oporto and Vimieiro, and for the small boats to pass the rapids above that place, for which reasons during the Summer season the middle sized boats alone are employed to go the whole way to Pezo de Regoa but these even can only take two thirds of their loading to Vimieiro, and they are attended by small boats with the remainder to compleat their cargo at that place.

Augst. 4th.—This day the two Companies of R. Artillery, assisted by a Detachment of the 4th Regt. of Portuguese Artillery, Commenced the operation of shifting the Battering train and Engineers Stores from the transports into Boats, and the work continued without intermission from day light in the morning till dark at night, except when delayed by want of Boats.

In the mean time all the workmen in the arsenal, with a number of additional ones hired for the purpose, were employed in altering the Carriages for Bullock draught, in making lamboens of which 300 were required, and also about 600 or 700 open Boxes, to be placed on the Bullock Cars for the Conveyance of Shot and Shells—these Various works requiring at least 10 days to compleat.

Digitized by Google

The Boats as they were loaded were sent off in Divisions as follows :—

	Boats. Large.	Small.
August 7*th.*—Sailed	21	19
8*th.*—Do.	19	18
9*th.*—Do.	26	13
10*th.*—Do.	12	2
The work now delayed for want of Boats.		
11*th.*—Sailed	4	3
Still delayed.		
12*th*	9	15
13*th.*—Sailed	7	10
14*th.*—The remainder of the Stores loaded and sent off	7	9
Total	105	89

The whole train therefore was dispatched up the river in 194 Boats, with all the altered Limbers and Carpenters work which had been executed at Oporto.

Lieut. Lindsay was sent off on the 11th to Pezo de Regoa, to make arrangements for receiving and landing the Stores,—and on the 16th August The British Artillery with a Detachment of Portuguese Artillery and Artificers marched for the same destination.

14*th.*—This day Major Dickson was attacked with a Severe fever, which rendered it impossible for him to continue the duty, he therefore on the 17th August sent off an express to Lord Wellington at His Head quarters Fuente Guinaldo, to inform him of the same, and his Lordship in consequence dispatched Brigade Major May to Lamego to superintend the further movements of the train.

His Lordship in consequence of Major Dicksons Communication of the 1st, approved of the proposition for avoiding Trancoso, and He authorised the train proceeding by any other Route Major Dickson might prefer, at the same time giving him directions to notify to His Lordship the place he fixed on for the first Depot; In consequence of this Major Dickson Selected Villa da Ponte as the point of Assemblage instead of Trancoso. His Lordship also gave orders to have the road repaired which leads across the Coa to Almeida.

September 3rd.—The Passage of the train up the Douro, and its debarkation at Pezo de Regoa, was effected with the Utmost regularity without any Material loss or accident, and by the exertions and Excellent Arrangement of Mr. Deputy Commissary Genl. Boyes *in* supplying the means of transport, the train was forwarded in divisions to the Rendezvous at Villa da Ponte, after which the Bullock Cars returned to Pezo de Regoa for a second load.

4*th.*—Major Dickson being recovered from his illness, he left Oporto this day, and reached Lamego on the 5th Sept.; where he

Digitized by Google

found Brigade Major May preparing to set off for Villa da Ponte, having dispatched the whole of the Ordnance with the exception of the mortars, and the greatest part of the Ammn.

9th.—After arranging with General Bacellar with regard to the Detachments of Portuguese Artillery and Militia for the Service of the train, and having settled with Mr. Boyes every thing for keeping up and supplying the transport, Major Dickson left Lamego on the 8th, and joined the train at Villa da Ponte on the 9th, where he found Major May busy in repairing all damages occasioned by the March.

There is a great deficiency of Wheelers in the train, to put to rights the 24 Pr. Wheels, which have been a good deal shook by the March in consequence of their dryness from having been so long on board of ship, which renders it necessary that they should be drawn together.

It is but justice here to notice, the admirable manner the roads had been repaired under the Superintendance of Senhor Manuel Camello Fortes da Pina Ozorio, Captain Mor and Governor of Linhases, to whom General Bacellar had entrusted this duty: The difficult turnings in Villages, hollow ways, and other objectionable parts, had been avoided by detours, which in many cases were opened through Vineyards and other Cultivated ground.

Sept. 19th.—Previous to this period Major Bredins Company having been removed from the train for Field Service, it was replaced by Capt. Halcombes Company which joined at Villa da Ponte this day. There are also attached to the train about 250 Portuguese Artillery men of the 4th Regiment under the Command of Capt. Miron.

Sept. 22.—Brigade Major May returned to Head quarters.

Sept. 25.—The following was the disposition of the train for movement:—

		Pairs of draft Bullocks.	Bullock Cars for Stores and Ammn.
1st Divn.	Lieut. Bourchier—12 24 Prs. ...	105	336
2nd Do.	Capt. Halcombe—12 24 Prs. ...	105	336
3rd Do.	Capt. Power— 10 24 Prs. / 4 18 Prs. ...	118	363
4th Do.	Lieut. Love— 20 5½ In. Howrs / 2 8 In. Do.	74	232
5th Do.	Capt. Miron— 8 10 In. Mortars	79	323
Spare ...	... ...	69	—
	Total 68	550	1590

	Bullock Cars.
Engineer equipment Lieut. Marshall	320

A much greater number of Bullock Cars were found necessary than originally calculated on, in consequence of the draft Bullocks of Beira and Tsar os Montes being small, and of a Description very

Digitized by Google

inferior to those of the Alemtijo—the quantity of cars before mentioned actually existed in the first instance, the greatest part of them soon after this period were sent to Lamego to assist in forwarding provisions to the Army, and by desertion and Casualties the numbers dwindled away in such a degree, that the train at no period afterwards had ever more than 400 Carts effective, Exclusive of the Engineer Dept. The draft Bullocks which were of an excellent description were never Seperated from the train.

Novr. 16th.—Major Dickson received an order to move with the train to Almeida.

18th.—Capt. Halcombe's 24 Pr. Division and Lieut. Love's Howr. Division marched. The Engineer Stores marched this day by way of Trancoso.

19th.—Capt. Power's 24 Pr. Divn. Marched.

20th.—Lieut. Bourchier's 24 Pr. Divn. Marched.

21st.—Capt. Miron's Mortar Division Marched.

22nd.—Capt. Halcombe and Lieut. Love reached Almeida with their Divisions, and the others arrived in succession.

This movement was accompanied by little or no Ammn., the Bullock Cars not having rejoined the train, a proportion however were soon afterwards Supplied, which were unremittingly employed all the month of Decr. in bringing forward Ammn. to Almeida, but from the season and the severity of the weather; it was impossible to do more than bring forward Gun Ammn., and the quantity of that even would have been insufficient, had it not been from the number of Eight Thousand 24 Pr. Shot found available for the British Guns, by a Careful Selection from the Accumulation of Shot in the garrison. As no part of the Shells therefore for the Mortars and Howrs. could be brought forward, the efficient train was reduced to 34 24 Prs. and 4 18 Prs.

As soon as the Battering train was Parked in Almeida the whole of the Draft Bullocks were sent back to the neighbourhood of Villa da Ponte for the sake of Forage.

1812.—*Jany. 1st.*—This day Lord Wellington issued the following memorandum, preparatory to the attack of Cuidad Rodrigo, it being determined that Gallegos shall be an intermediate depot to supply the Siege.

FRENEDA, *Jany. 1st*, 1812.

Memorandum for:—
Mr. Bisset.
Col. Fletcher.
Major Dickson.

1st.—The Cars sent by General Alava now employed in collecting at Las Agallas the Fascines, and Gabions, and pickets made by the Light and 3rd Divisions, and all the cars at the Cantonments occupied by the Light Division, and M.-Genl. Colvilles Brigade in the 3rd Division, to Rendezvous at Las Agallas on the 5th to be loaded with Gabions and Fascines and pickets on the same day, and to move on the following morning to Cuidad Rodrigo.

2nd.—Colonel Fletcher will charge the Officer of Engineers at Las Agallas with the management of this concern.

Digitized by Google

3*rd*.—The 90 Cars unemployed and in readiness, and the 66 expected to arrive this day are to be sent on the 2nd to Almeida, 50 of them are to be loaded with the Laboratory and Small Stores required by Major Dickson; 106 must be loaded with what is required by Colonel Fletcher and to move on the 3rd to Gallegos.

See Seperate Memorandum.

4*th*.—All the Cars in the Cantonments occupied by the 3rd Divn. except M.-Genl. Colvilles Brigade, by the 4th Divn. including those sent by Genl. Alava and Genl. Paele's Brigade, by M.-Genl. Stopford's Brigade, and the 40 Carts expected from Don Julian, are to rendezvous at Gallegos on the 5th, on which day they are to be loaded with Fascines and Gabions.

5*th*.—The 16 Carts at Saelices are to be loaded with Fascines and Gabions at Saelices on the 5th.

6*th*.—The 50 Carts which will have brought the Laboratory and Small Stores of the Artillery to Gallegos on the 3rd, are to be unloaded the same day and to be loaded at Gallegos with Fascines and Gabions.

See Seperate Memm.

7*th*.—The Carts mentioned in the 3rd, 4th, 5th and 6th Articles are to move to Cuidad Rodrigo loaded with Engineer Stores on the 6th.

8*th*.—The Mules (50) in the Engineer Dept. to be sent on the 2nd to Almeida to be loaded with Engineers tools and to proceed on the 3rd to Gallegos, on the 4th to return to Almeida for the remainder of the tools, on the 5th to Gallegos, and on the 6th to Cuidad Rodrigo.

9*th*.—53 Mules with the 1st, 48 with the 3rd, 57 with the 4th, 68 with the 7th, 102 with the Light Divisions.

To proceed to Almeida on the 3rd, and to be loaded with powder and shot in their proper proportions; and to proceed on the 4th to Gallegos.

10*th*.—The Gun Bullocks now grazing at and in the neighbourhood of Celevico to go to Almeida as soon as possible to draw the guns from Almeida to Gallegos on the ——— and from Gallegos to Cuidad Rodrigo on the ———.

11*th*.—In proportion as the mules belonging to the reserve Ammn. of the 5th and 6th Divns. and Cavalry will arrive at Almeida with powder and shot (from Villa da Ponte) they are to be loaded with powder and shot in their due proportions, and sent on the 1st day to Gallegos and on the 2nd to Cuidad Rodrigo.

12*th*.—The Carts now employed with Major Sturgeon, and the new Carts are to be sent to Almeida, as soon as he will have done with them to be loaded with powder and shot in their due proportions, and to carry these articles to Gallegos, there lay them down, return the following day to Almeida, and the following day bring Fresh loads to Gallegos.

13*th*.—The Mules mentioned in the 9th and 11th Articles will be employed to carry this powder and shot forward from Gallegos to Cuidad Rodrigo.

14*th*.—The Carts mentioned in the 1st, 3rd, 4th, 5th, and 6th Articles are to return to Gallegos and Las Agallas on the day after

Digitized by Google

they will have quitted those places to be reloaded with Fascines and Gabions, &c., are to proceed on the following day to Cuidad Rodrigo.

W.

N.B.—It is desirable that the mules mentioned in the 9th Article should lodge the Ammn. (Small Arm) at the following places on their way to Almeida :—

That of the 1st Division Alameda.
That of the 3rd and 4th Do. Gallegos.
That of the 7th at Sabugal.
That of the Light Division at Guinaldo.

FRENEDA, *Jany.* 1*st*, 1812.

Seperate Memorandum for :—
Mr. Bisset.
Col. Fletcher.
Major Dickson.

Ninety Cars now at Freneda, and sixty six expected from Brigr. Alava, to be sent on the 2nd to Almeida to be loaded, 106 with Engineer Stores, and 50 with Small and Laboratory Stores of the Artillery, to carry these Articles on the 3rd to Gallegos, return on the 4th to Almeida ; and load with Powder and Shot, return on the 5th to Gallegos, and lay down the powder and shot, and to be reloaded with Engineer Stores to proceed to Cuidad Rodrigo on the 6th.

W.

Jany. 3rd.—The movement of the Stores to Gallegos commenced this day as directed in the foregoing Memoranda, and Continued with as much activity as the Supply of transport would admit.

Memorandum, Jany. 4th, 1812.

1st. Eighty Carts only of those which left Almeida yesterday and are now at Gallegos, to be sent back to Almeida, to be there loaded with Articles for Col. Fletcher, and to proceed to Gallegos the 6th.

2nd. Forty Carts of those now at Gallegos to come to Freneda on the 5th to be loaded with Stores of Col. Fletcher at Freneda, and to go to Gallegos the 6th.

3rd. The 45 Carts which were sent to Almeida this morning, to be loaded with powder and shot, and to go to Gallegos on the 5th and there remain, the powder and shot being laid down at Gallegos.

4th. All the Carts which will go to Gallegos excepting the 80 and 40 ordered away by the 1st and 2nd Articles of the Memorandum, to be detained there and loaded with materials and stores of the Engineers Department.

W.

Instructions to General Officers Commanding Divisions.

Jany. 8th.—The Commander of the Forces proposes to attack Cuidad Rodrigo, and in order that the troops may suffer as little as possible from exposure to the weather, he intends that the operations shall be carried on by each of the Divisions of the Army employed alternately for 24 hours.

Digitized by Google

B.-General Packs Brigade with the exception of the 4th Caçadores will do duty with the Light Division.

The 4th Caçadores will do duty with the 1st Division.

When a Division is ordered for the duty of the Siege, each of the Battalions belonging to it is to march from its Cantonments before day light in the morning, the troops from the Several Cantonments of the Division Seperately, by the shortest and most Convenient route, which the General Officers Commg. Divisions are requested to ascertain, the Troops will be able to cross at the Fords above La Caridad, and all the fords below the Ford of Carbonero inclusive. The troops are to have with them a Days Provisions Cooked, and they are to be followed by two Days Spirits and no other baggage.

A Sufficient number of men to Cook the Provisions for the Day the Division is relieved, are to be left in the Cantonments.

As soon as the first Battn. of the relieving Division shall move on the ground, the General Officer Commanding the Division which has performed the duty for the preceding 24 hours will commence the relief by sending off to their Cantonments a proportionate number of troops, those of course first, which have the greatest distance to go to their Cantonments, and the relief will proceed in proportion as the troops shall arrive.

The Chief Engineer will require daily from each Division—

20 Miners.

30 Artificers or persons accustomed to work, with a porportion of Non-Commd. Officers.

These men will be fixed upon before the troops march from their Cantonments and are to be placed under his directions, (with a list of their names and the Regts. to which they belong) on the arrival of the troops on the ground.

Each Regiment is to take along with it the Intrenching tools belonging to it.

There will be orders daily respecting the working parties, Covering parties, Guards, &c.

The Musket and Rifle Ammn. attached to the Light Division is to be taken to the ground the first day and remain there.

The 9 Pounder attached to the 4th Divn. will likewise be taken to the ground the first day and remain there. The Artillery men are to be relieved Daily by those belonging to the Brigades and troop attached to the 1st, 4th, and Light Divisions.

The Engineers will order to the ground a Sufficiency of cutting tools to enable those men not immediately on duty to supply themselves with Fire wood. These tools to be handed over from the Relieved to the Relieving Division.

Each Division to be attended by the Medical Staff belonging to it, a place will be fixed upon to which Men who may be wounded are to be carried to be dressed, and means will be provided of removing them from thence to their Cantonments.

(Signed) WM. DELANCEY, *D.Q.M.G.*

Digitized by Google

Jany. 8th.—Cuidad Rodrigo was invested this day, and the trenches were opened at night, after the Redoubt Renaud on the upper Teson had been carried by assault.

Jany. 11th.—The Gun Bullocks having arrived at Almeida on the afternoon of the 9th, the train marched from thence the following day for Gallegos, and on the 11th continued its march to the ground marked out for the Park near Cuidad Rodrigo, the ordnance being as follows :—

24 Prs. Iron of 9 feet on travelling carriages	... ...	34
18 Prs. Do. of 8 Do. on Do. Do.	... ...	4
	Total ...	38

with a proportion of Spare Carriages, Forges, Gins, &c., &c., to Compleat, and by the Evening of the 11th there was in the Park all the Laboratory and General Stores required for the Service, with two days Ammun. for 38 Guns, a similar quantity being in Depot at Gallegos in readiness to bring forward.

A proportion of Bullock Cars were assigned to bring forward Ammn. from Almeida to Gallegos, and the Small Arm Ammn. Mules were to Convey the Supplies from Gallegos to the Siege, to keep up the proportion for two days firing.

The Corps of Artillery under Major Dickson's orders for the Service of the Siege was as follows :—

British Artillery.

Captain Halcombes Company, N.C.O. and Gunners ...	96
Capt. Glubb's Do. under Capt. Power, Do. Do. ...	75

Portuguese Artillery.

1st Regt. Artillery	From Capt. Cunha's reserve Brigade of 6 Prs.	70
	From Lieut. Costa's reserve Brigade of 6 Prs.	70
Detachment of 4th Regt. of Artillery, under Captain Miron		230
36 Guns.		
6	Total ...	541
	Deduct two reliefs ...	432
216 at 6 men each.		
2	For Laboratory and Magazine duties, Escorts, and to replace casualties	109
432 number of men for two reliefs.		

British Officers Names.

Capt. Halcombe.	Lieut. Bourchier.
Capt. Dundas.	Lieut. Love.
Lieut. Goeben, K.G.L.	Brigade Major May.
Lieut. Grimes.	Capt. Dynely.
Capt. Power.	

Digitized by Google

Portuguese Officers Names.

1st Regt.	4th Regt.
Capt. Joaó de Cunha Preto.	Capt. Joao Victoria Miron.
Lieut. Antonio da Costa e Silva.	Capt. Francisco Januario Mariz.

With a due proportion of Subalterns of both Regiments.

Night between 13th and 14th Jany.—This night Guns were got into the Batteries as follows :—

No. 1.—Two 18 Prs. against Convent St. Francisco.

No. 2 } Two 18 Prs. / Seven 24 Prs. } To breach the body of the Place and Fausse Braie at the Saliant Angle of the Fortress.

No. 3.—Sixteen 24 Prs.

Jany. 14th.—About an hour before sun set the batteries opened, viz.—

2 18 Prs. against St. Francisco.

2 18 Prs. / 23 24 Prs. } To batter in breach distance from 560 to 580 yards.

The chief object of the two Guns against St. Francisco, was to open the garden wall of the Convent, but the swell of the ground in front of the Battery, prevented the Guns from bearing on the Wall, the fire however was continued on the body of the Convent till dark, but without much apparent effect.

By the time the fire of the breaching batteries begun to be Correct and Steady, it was obliged to cease on account of night setting in.

The Enemy kept up a Tremendous fire of Shot and Shells, but without any very material effect.

The Convent of St. Francisco was carried by assault this night.

Jany. 15.—As soon as it was day light this morning, the breaching batteries recommenced their fire with 23 24 Prs. and 2 18 Prs., and continued the same during the whole day without intermission, and by the Evening the Wall of the Fortress was so much shook and injured as to afford great hopes of success.

The Enemy kept up a heavy fire particularly of shells which occasioned a good many Casualties.

Night between 15th and 16th.—Five 24 Prs. were got into No. 1 and 2 this night.

Jany. 16.—Batteries opened in the morning with 28 24 Prs. and 2 18 Prs. against breach but so heavy a Fog came on they were obliged to cease firing at ½ past Nine oclock.

The Expenditure of Ammunition to this period, was 2,790 Rounds of 24 Pr. and 340 Rounds of 18 Pr. Shot.

Jany. 17.—This morning still continued very Foggy but it cleared up at noon. The breaching batteries as soon as it was sufficiently clear to point the Guns, continued their fire without intermission till night, and with such effect, that a Considerable portion of the Wall both of the Fausse Braie and body of the place was beat down. Nor were the Enemy idle for they kept up an incessant fire of Shot and Shells which occasioned a good many Casualties.

A 24 Pr. in No. 2 was rendered Unserviceable by being struck in the

Digitized by Google

Muzzle, several 24 Pr. Wheels were demolished, and a number of the Platforms were blown up by Shells.

Night between 17 *and* 18.—Battery No. 4 intended to form a Second breach was armed this night with 7 24 Prs., Four of which were taken from No. 1 and 2, and three Brought in from the Park.

Jany. 18.—The batteries opened this morning at day light as follows:—

No. 1, 2, 3 { 23 24 Prs. / 2 18 Prs. } against the great breach.

No. 4 { 7 24 Prs. } To breach a Tower to the left of the great breach distance about 550 yards.

The fire continued the whole day without cessation, the great breach began to put on a very favorable appearance, and in the evening it was considered practicable.

Battery No. 4 was very successful in its effect against the Tower, which by the Evening was in a very ruined state.

The fire of the Enemy was as Severe as ever, indeed they had nothing to impede them in their practice, for not a Single Shot had been fired against their batteries since we commenced.

One of our 24 Prs. burst in No. 3 from a High Shot getting jammed half down the bore, by this accident one English and one Portuguese Artillery man were killed, and two of the former, and three of the latter wounded.

The expenditure of Ammn. from ½ past Nine oclock on the 16th, to mid-day on the 18th, was 2,754 rounds of 24 Pr., and 150 rounds of 18 Pr. shot.

Night between 18 *and* 19.—Battery No. 5 in the 2nd Parallel being now in a forward state, a 5½ Inch Howr. and 6 Pr. from the Field Artillery, were placed in it this night to keep up a fire on the breach.

Jany. 19*th.*—At Day break this morning the batteries resumed their fire as follows:—

22 24 Prs. / 1 18 Pr. } against the Main breach.

7 24 Prs. against the Tower Do.

In the afternoon both breaches being Considered perfectly practicable, the fire of the batteries was turned on the defences, and Continued till the Columns were about to move on to the assault.

The Expenditure of Ammn. from mid-day on the 18th till the period of the assault was 3,406 rounds of 24 Pr. and 75 rounds of 8 Pr. Ammn., and the whole Expenditure of Ammn. during the Siege was as follows:—24 Pr. Round, 8950; 18 Pr. Round, 565; Barrels of Powder, 834.

There remained three 24 Prs. in the Park that were never brought into the Batteries.

From the Casualties and Severity of the duty, it became necessary in the two last days to call into the batteries part of the Detachments of Divisional Artillery attending the Siege, in consequence of which Captain Alfred Thompson and Capt. Sympher served in the batteries

Digitized by Google

successively with part of their Brigades, assisted by Lieutenants Johnstone and Ingleby of the Royal Artillery, and Lieutenants Schulzen, Riefkugel, and Blumenbach of the German Artillery.

The Field pieces in No. 5 during the night of the 18th, were under the direction of Lieut. Smith of the Horse Artillery, who kept up a Vigorous fire.

The Columns for the Assault were accompanied by Detachments of British and Portuguese Artillery, under Lieut. Bourchier of the Royal Artillery, Lieut. Blumenbach of the German Artillery, and Lieut. Joze da Silva of the 1st Regt. of Portuguese Artillery, all which Officers were Volunteers for the duty.

The killed and wounded of the British German and Portuguese Artillery during the Siege were as follows :—

	Killed.				Severely Wounded.				Slightly Wounded.			
	Officers.	Sergts.	Rank and File.	Total.	Officers.	Sergts.	Rank and File.	Total.	Officers.	Sergts.	Rank and File.	Total.
British ...	—	—	1	1	—	—	6	6	2	1	17	20
German ...	—	—	1	1	—	—	1	1	—	—	2	2
Portuguese	—	—	6	6	—	—	10	10	2	—	25	27
Total	—	—	8	8	—	—	17	17	4	1	44	49

Killed 8
Severely Wounded ... 17
Slightly Do. ... 49
74

Names of Officers wounded.

Captain Power — Slightly
Captain Dynely — Do.
Lieut. Antonio da Costa e Silva — Do.
Lieut. Alberto Joze Guerseiro — Do.

and considering the number of pieces of Ordnance bearing on the attack, and that 12,000 heavy Shells fell on so small a space, the Casualties were not very great.

Lord Wellington in his dispatch expressed himself well satisfied with the Conduct and exertions of Major Dickson and the Officers and men under him, and he particularly mentioned Brigade Major May, and Captains Halcombe, Power, Dynely and Dundas of the Royal Artillery, and Captain Cunha, Lieut. Costa, and Lieut. Silva of the 1st Regiment of Portuguese Artillery.

Lieut. Francisco Pedrozo Barreto, of the 4th Regt. of Portuguese Artillery, deserves also to be mentioned for the zeal and good conduct he displayed on all occasions.

In concluding this detail, it is but Justice to notice Mr. Butcher, Assistant Commissary of Ordnance, in charge of the Battering train, who materially assisted in the operation, by his activity, exactness, and good arrangement.

A.D.

(*To be continued*).

Digitized by Google

A LADY'S EXPERIENCES IN THE GREAT SIEGE OF GIBRALTAR (1779–83).

BEING THE DIARY FROM 1ST JUNE, 1779, TO 13TH JUNE, 1781, OF MRS. GREEN, THE WIFE OF LIEUT.-COLONEL GREEN, CHIEF ENGINEER OF GIBRALTAR (AFTERWARDS LIEUT.-GENERAL SIR WILLIAM GREEN, BART., CHIEF ENGINEER OF GREAT BRITAIN, 1786—1802).

(Continued).

Saturd 25. Easterly wind, a fine Day. Find myself but very indifferent, am very much out of Spirits on many accounts, as I meet with many Vexations which I did not expect. 25th March, 1780.

Sund 26. *Easter Day.* Easterly wind. A very fine Warm Morning. I walked out before Dinner with the Child, find myself very indifferent whilst out and come home very Low. A Man of the 39th and one of 73rd Deserted last Night from the Back of the Hill. We were quite alone in the Evening. I went to See Mrs Lewis this Day. The Small Pox in many parts of the Garrison. No Innoculation allowed of as yet.

Mond 27. Easterly wind, very Dull indifferent Day. The Colonel exceedingly displeased with publick Business, and still more after Breakfast continued greatly displeased all Day. He went to the American Club. N.B. This is the first Meeting of the American Club.* He is President. Came home at 9 in the evening in tolerable spirits. It began to Rain in the evening. Children Dieing every Day. George taken very ill in the Evening; pain in foot.

Tuesd 28. Easterly wind. It Blow'd and rain'd exceedingly all Night, and so bad a Morning that the Review of the 12th was obliged to be put off. It continued a very Wet Day. Hear that Colonel Mawhood has broke his Arm by a fall as He was going to the Southward last Night. The Same discontent in the Colonel and the same Causes. N.B. This Circumstance first began by an affair of Lt Skinner's, relating to Some few Libertys taken concerning the Cattle. N.B. Capt Evelegh has got a piece of Ground allotted to him, the same where The Wind Mill was first put up, which was begun and fail'd; all Under the Direction of Capt Evelegh.

Wed 29. Easterly wind. The Morning pretty fine. Hardenburgh's Regt Reviewed. The Day continues good. A visit from Col Ross. George still ill in his room.

* See Sept. 14, 1780.

Digitized by Google

30th March, 1780. *Thursd* 30. Easterly wind; a fine Morning. The 52nd reviewed. The Gov^r has given the name of Mill Mount to the piece of Ground which he has given Capt Evelegh. N.B. It is where that Gentleman had Erected the Windmill, and without any Success. Several Ladies at the Review.

Fry 31. Easterly in Morning; turn'd out a very fine Day. The 39th reviewed, and to the Astonishment of every Body Col Ross attended as Lt Col to the Regt. He had never been with them at any of their Field Days, or done any Duty, for Many Months. It was not known to any of the officers that He would be there; but just before the Regt went on He sent to Col Kellet and inform'd him He had let the Gov^r know He intended to fall in with the Regt. In the same time Genl Boyd* went on to the Parade but never Joyn'd the Regt, only as a Spectator as on other Days. The whole went on pretty well; better indeed than it could be expected, as it was very Reasonable to think the men were taken at a disadvantage by the changing the Commanding officer that very Morning. There was no Regimental Breakfast, every body went as they chose. The whole Regt dined as others have done at the Gov^rs. Genl Boyd also dined there in his General's Uniform with his Aid de Camps, not making himself Colonel of the 39th the whole Day. All pass'd very well, but he or Col Ross did not speak to each other. Many People think these two Gentleman will never Settle the Coolness that is between them; as the Dislike seems to increase. They are both very Valuable Characters. In the Evening Colonel Ross came here. I was alone at the first; and as Usual heard all the Story. All Ended Well.

During the course of this last Month the Enemy may have been rather Slow in their business of all kinds. Towards the last few Days they seem beginning to show more Spirits. Certainly they are not going away. Would to God They either would leave us or show themselves in Earnest. We cannot be said to enjoy any great degree of Ease or Comfort just now. The kind of Necessity that the Gov^r has found out to change the Provisions has occasioned a great deal of discontent. The Troops never objected to any Method when an appearance was of a Serious Nature, but now they seem to think it hard to be obliged to eat so much Salt Fish when it is Well known there is an amazing Quaintity of Beef and Pork! Salt Fish without the proper Sauces is but poor Diet, and particularly in the Hott Season now coming on.

Saturd April 1st. Westerly Wind. This Morning was very fine. A Hanoverian Regt, Redan's, was Reviewed. All very Well. A Deserter came In from Spain, the Wolona Guards. Colonel and Mr.

* General Boyd was Colonel, and Colonel Ross, Lieut.-Colonel of the 39th.

Digitized by Google

Holloway dined with Lt Cuppage. George still Confined to his Room. Gun Fir'd at 9 oclock this Evening. 1st April, 1780.

Sund 2. Westerly wind, a fine looking Morning. Set down to write letters to England in hopes the Store Ships will sail soon. The Guards Mount at 7 in the Morning. N.B. Every Sunday there is the Same kind of publick Works going on as on Week Days, and a Continuation of many Unpleasant Circumstances. This Morning the Enemy Seem to have large Quaintities of Straw and other Stores landing at the Usual Places; by which it does not appear as if they had any Idea of leaving the Camp. We now most heartily wish they would show their real Intentions.

Mond 3. Westerly wind. The *Porcupine* Frigate sail'd last Night for Minorca and Algiers, on board of which was Mr Wilks &c, and Mr Davisson. Genl Boyd sent Us a very fine hind Quarter of English Mutton yesterday. George still very ill and confin'd to his room since this Day Week. Doctor Baynes informs me that the Small Pox broke out upon a Man of the Highland Regt on Fryday last. N.B. This is the first Soldier that has got that Disorder. At this time there is a Number of Children ill with it. Captain Knowles a Master of a Transport Well known in Gibraltar, and who has been here a long time, Died rather Suddenly. It Rain'd this Evening. It is now Supposed the Gov^{r} will allow of Innoculation, as He has said He would have no objection to it whenever the Troops took the Small Pox.

Tuesd 4. Westerly wind. A Review of the 56th Regt. A fine Morning. Charlotte was greatly indisposed all Night quite Burning with Heat. I gave her one of the Small Pills, and she Grew very ill afterwards. Doctor Baynes is of the opinion she is Breeding the Small Pox. The child has not been quite Well these last Ten Days. She continued greatly indisposed all this Day and was Bath'd in Warm Water going to Bed.

Wed 5. Westerly wind. De la Motts Regt Reviewed. This Morning the *Fly* Pacquet Boat came In from Barbary, brings a few Fowls, oranges, and onions,— all Selling exceedingly Dear. Fowls 2 Dollars a piece, oranges half a Rial, onions 2 Rials pr pound. Brings Word that the Brig belonging to Mr Mowbarry and Mackellar was drove into Tetuan Bay two Nights agoe by contrary winds as she was coming over and is now safe there. Charlotte much better in Evening and the fever most over. George exceeding ill.

Thursd 6. Westerly wind. This morning 2 Market Boats came In from Barbary, bring a happy supply of Bullocks, 36, and Some Fowls, Oranges, &c, all Selling very Dear, Fowls 2 Dollars, and upon the whole full as dear as that which came yesterday, says that the Brig is still in Tetuan Bay. They bring good News of some Engagement which was confirm'd by a Servant who came from the Consul (Mr Logie) to our Gov^{r} to inform him that our Fleet had an

Digitized by Google

6th April, 1780. Engagement with the Spainiards going home from hence. Charlotte had a very good Night and continues quite well to Day. George exceedingly ill and in Violent pain, not able to Move in his Bed without help. A Deserter came In this Morning of the Wolona Guards. The Soldier of the Highland Regt is well and has had an exceedingly fine Sort of Small Pox. No Innoculation allowed of as yet. Most People are displeased at this as it is certainly much better for the men and poor children to have this Disorder now than when it is Warmer. For my own part I am exceedingly Anxious for our Dear little Girl; and did it depend wholly upon myself I would not ask any leave.

Fry 7. Westerly wind. The 58th Review. Hear a further account of the Engagement between our Fleet and the French going from hence to Engd. Also We hear that Sir George Rodney was at Madeira upon the 19th of Febry. He sailed from hence upon the 14th. The Colonel dined at Genl Boyd's this Day. Mr Holloway with me. George continues exceedingly ill. Charlotte quite well. The *Fly* Pacquet Boat went to Barbary this Evening. The Fowls 20 Rials a piece.

Saturd 8. Westerly wind. The 72nd Review. Bought some Veal for which I gave 6 Rials per lb. Resolve to go to the Mount as the Weather was so fine. George still Confined to his Room. Got a New Hat and Silver Band &c for the Postilion. We have not bought any of the Fowls. The Col: not exceeding well pleased at the Mode of carrying on Business. N.B. Nor is any of the Commanding officers satisfied,—so little attention shew'd to Them.

Sund 9. Westerly wind, fine Morning. Went to the Mount in the chaise to Breakfast, took Charlotte and her Maid staid there till Tuesday Evening. On Monday a Boat arrived from Barbary, brings Word of a Certainty of our having had an Engagement with the French, and also that an English Fleet was hourly expected at Cadiz.

Mon 10. Cold Westerly wind. George rather better.

Tuesd 11. Westerly wind. Nothing particular. Small Pox raging very bad, children dying every Day. Din'd at the Mount and came Home in Evening on account of some Business. Find I have a Cold in my Head. Commodore at the Mount.

Wed 12. Westerly wind but rather Cool. Great Uneasiness about some *Engineering* Business, the Colonel much hurt at it and had some *particular conversations* with Capt Phipps and Capt Evelegh &c. The Small Pox increases. I am very much indisposed in the afternoon. This evening about a Quarter after 8 we were all Surprised by the Alarm Drums Beating. We had several Gentlemen in the Parlour, who all Run out, but soon returned bringing Word it was nothing of any Consequence, only a Fire amongst some Shavings of Wood in an out House belonging to the Convent, Supposed to

Digitized by Google

have been set on Fire by a Squibb from Some Children at play. This Night about 11 oclock Capt Leslie of the *Enterprize* fired 4 or 5 Guns, not known at what ! 12th April, 1780.

Thursd 13. Westerly Wind. This Morning at Gun Fire two Market Boats, or rather one, the other being the Privateer, *Saucy Jack*, arrived from Tangier with a Packet of Letters and some Bullocks, Fowls, and Oranges &c. We Rec^{d} some letters and 4 News Papers. I had one letter from My Daughter Nicolls, dated Jan 28th by which We learn that our Son's Commission of Captain was dated 24th Decr 1779. Our oldest paper dated 15th Jan. the latest Feb 5th. All well in our Family at that time. The Colonel also Rec^{d} his acct from his Agents. I have had a very bad N^{t} and am Lame, exceedingly ill so as to keep my Bed, fear I shall grow worse as the Complaint seems to increase in all Limbs.

Fryd 14. Westerly wind. A Deserter came In, brings a confused account of the Enemy's Intention to Advance. I went down to dinner but found a very great pain in my Left Knee. Quite alone in evening. Several Guns were Fired in the Bay at 10 oclock at Night.

Saturd 15. Westerly wind. Find myself growing exceeding bad ; a most Violent Headache ; likewise my Leg and Knee, could not get up. Hear that the Firing was occasioned by the Arrival of the *Hyena* Frigate from Eng^{d} 20 days from Portsmouth. Capt Thomson has brought very Particular Dispatches for the Gov^{r} and Commodore Elliot. We hear she is likely to go back very soon ; must therefore try to send home some letters if it is in my power to write ; but I now keep my Bed, not being able to bear the Moving. I sit up and wrote a long letter to my sister this Morning and inclosed one I had wrote in part since the first of this Month to my Mother. This was all I could do to Day. I Rec^{d} a letter by this Frigate from Lady Rich from Portsmouth ; fear it will not be in my power to Answer it as I am exceedingly ill.

Sund 16. Easterly wind. The Frigate seems likely to be going. Every Body is hurrying to write letters. The Colonel Busy in getting Public papers ready. I sit up in bed and write a long letter to my Son on his Promotion. This Day my pains moved into my Right Leg and nothing can exceed the Agonies I am In. An other Deserter came In, brings In a further Confirmation of the Enemy's Intention ; in bed all Day.

Mond 17. Westerly wind. Ships not gone. Am worse this Day than yesterday, and at Night beyond all possibility of bearing it with any Degree of Patience. The Small Pox Raging greatly and has got among all the Regts. A Man of the Soldier Artificers exceedingly bad with it. No Innoculation yet !

Tuesd 18. Westerly wind. Have had the Worst Night I ever experienced in my Life. Write this in my Bed. Continue exceedingly bad at Day and at Night.

Digitized by Google

19th April, 1780.

Wed 19. Easterly wind. Not able to get up. Take Dover's Powders. Ships not gone. The Garrison very Low and Dull.

Thursd 20. Easterly wind. The same. The *Edgar* Commodore Elliot and the *Hyena* Frigate Capt Thomson sailed, and in the afternoon Admiral Barcelo went out.

Fry 21. Easterly wind. *Colonel and Gov*r upon the Parade. Find myself a very little Easier. Take more of James Powders; can not sit up yet. The Man of the Highland Regt Recover'd.

Saturd 22. Westerly wind. Seem a little Easier; set up a part of the Day. The Man of the Artificer Company very bad.

Sund 23. Westerly wind. I was taken up in the Course of the Day but not able to Stand. 7 Men Died of the Highland Regt between last Night and this Evening, of a Flux and Fever. They had lost near 100 before. Barcelo return'd to Algezira. This Even about 8 oclock a very bright and Remarkable Meteor was seen in the Sky, resembling a burning, flying Kite,—Viz., a Blazing Star; Seem to take its direction towards the Queen of Spain's Chair. Find myself tolerably Easy when going to Bed. My Foot greatly swelled.

Mond 24. Westerly wind. Had a much better Night than *I* have of late, tho' did not Sleep but very little after 3 oclock. Got up at 11 but only could be set in a Chair by the Bed Side. Rather low all Day. Barcelo has return'd back to his Station two Days. The Small Pox exceedingly raging; Children also Dieing. Hawkins of the company very bad with it.

Tuesd 25. Westerly wind. My Lameness no better; but had a little Rest last Night,—not a bit better able to Move. Set all Day in my Chair, between Window and Bed. Charlotte got a bad Cough. Mackellar's Vessel arrived on Sunday from Barbary.

Wed 26. Westerly wind. Did not Sleep quite so Well but find my Leg rather Easier when I got up. If I continue so to Morrow, mean to be taken into Dressing Room. This Even Hawkins died. Col: and Mr Holloway dined at Genl Boyd's, Supt at Phipps. This Day a Spainish line of Battle Ship anchor'd near Point Negro. She remained all Day and Evening.

Thursd 27. Easterly wind. A Boat arrived from Malaga, last from Tangier, with oranges, Eggs, and oil. She is going to Faro. This forenoon Don Barcelo and two Line of Battle Ships got Under Sail and went towards the West. I came out this Day to my Dressing Room, being brought out by two Women, after having been in my Bed Room 14 days, Wrote some more in a letter to my Daughter Nicolls in hopes to get an opportunity to send it. N.B. I did not mention that the Troops had Soft Bread issued out to them upon the 24th for the first time since the Fleet left us, (they having had Biscuit all that Period). Great complaints now making about Salt Fish.

Digitized by Google

Westerly wind. Hear that Barcelo was return'd, and also thoughts of the Store Ships going was over, it being impossible them have any Convoy. A Boat arrived from Malaga that is to go to Portugal as soon as possible. Very Lame still. 28th April, 1780.

Saturd 29. Westerly wind. Obliged to be brought out the Same as before. Much confused talk of the Enemy's Intention to Fire upon the 1st of May. They are landing Stores of all Sorts at Point Negro. This Day and for these Days past the Colonel has been rather Low and Dull, owing to many Unpleasant Circumstances in business.

Sund 30. Westerly wind. Brought out again by the two Women. N.B. I try'd all I could in the Course of Yesterday to assist myself and Strove all that my Strength would allow to Stand, but it was attended by my growing a great deal Worse for it. The Same Unpleasant talk of to Morrow Firing. This Evening about half past 9 a Sudden Fire broke out in the Enemy's Camp. We did not at first know what to make of it. It continued to burn very Smartly indeed for half an hour. It appeared as if it was behind the Camp. We heard their Drums beating most of the time. N.B. Upon the 16th of this month the following Memorandum was given to the several Adjts at Orderly time, but it was not put down as Orders. I was then so ill that I omitted to set it down in its proper place.

"The Governor permits all officers who have enclosed and Cultivated ground to keep it during their residence in the Garrison on Condition that they shall send to the publick Market all the produce they do not make use of themselves and that they do plant Trees."

Various opinions form'd in Consequence of the above; to think what could induce the Govr to give out such Recomendations, particularly as he has encouraged Several officers of late to enclose Grounds &c, and also giving so large a place upon the Mountain to Capt Evelegh, and also at the South to Capt Witham. However it cannot affect Us at the Mount; ours being upon a different footing, as the Colonel pays a Yearly Ground Rent into the Revenue, and We do not allow ourselves to think the Govr has anything to do with our property. Mount Pleasant has now been near 5 years improvement and may most likely turn out of the Utmost advantage to the Garrison.

Thus ended the Month of April, and it is not very Easy to tell how exceedingly Uncomfortable all Ranks of People now are. This Circumstance of the Generals Refusing to allow of Innoculation has hurt all degrees of People. Several Men are quite Miserable at not being allow'd to Innoculate—12 men in one Regt were anxious—and it is the More to be Wonder'd at as the Govr did actually say He would not have any objections if it once got amongst the Troops, which it has now; and likewise has been already fatal.

Digitized by Google

1st May, 1780. *Mond May 1st.* Westerly wind, not so bright a Morning as of late. All has remained perfectly quiet from the Enemy, so that very little is to be depended upon from what is mentioned by flying Reports. We can plainly See where the Fire was last Night. It is in the Rear of the Camp amongst some Hutts, most likely Sutlers Hutts, and little shops. There seems to have been a good Many Burnt, indeed it was a very considerable time Burning, and We know they could have no Supply of Water. This Day keeps very Dull and Hott, looking like Rain. Various Reports still with Respect to the Enemy's Intentions, and the Inhabitants, Idly giving Way to their fears are all flying out to the South. This was the Second Monthly Meeting of the American Club. The Colonel was not very Well; however He went and Return'd in the Evening perfectly cool, and better than when He went out. About 7 it began to Rain and continued a fine Shower till 10, when I write this. My Lameness still very Troublesome, not being able to stand. A General Court Martial this Day upon a Man of 39th for theft, Col Cockran President.

Tuesd 2. Westerly wind, a pleasant Morning. Here the Enemy are busy landing Mortars and all sorts of Stores at Point Negro. Find myself very little better as to my Lameness; and am very Low spirited most of this Day. Mrs Phipps &c call'd. Col: pretty well. This Morning Doctor Baynes tells me He has been with the Gov^{r} and had talked with him about the Small Pox, and asked him this one Question; If it happened in a family where there were More than one child, would it not be a better Way to Innoculate the Rest of that family? as it was not to be doubted They would get it, and it would be the means of its being Sooner over. He answered: No; by no means! He could not answer it to his Conscience. What the Gov^{rs} Meaning is I know not; but I do think He ought to make a point of getting this cruel Disorder as soon over as possible well knowing the Violent Season coming on; and also to comfort many anxious Parents and others.

Wed 3. Westerly wind. Am still Lame. The Colonel not very Well and did not go to Parade. Many Idle Reports about the Enemys advancing and it was actually said They had begun to throw up Ground on this Side the Lines; and that two Engineers were seen in the Round Tower, as it is call'd, upon the Neutral Ground. It was afterwards Well known it was two Dogs that had been hunting about and had torn up the Ground. I saw the very officer who first observed them and absolutely distinguish'd the Different Colours of those very Dogs,—the officer at Forbes Guard,—He call'd up to the officer at the Lines and told him what it really was; but he was displeased and ask'd if He was not a Judge between 2 Dogs and 2 Men, upon which He (the officer at the Lines) made his report to the Gov^{r} who sent Word to the Capt of the Batterys that if He

Digitized by Google

observed any Troops, or even Partys to assemble on this Side their Lines, that He should fire all the Guns that He could bring to bear that Way. However all Remained perfectly quiet. 3rd May, 1780.

Thursd 4. Easterly wind early this Morning. I finished a letter to My Sister and sent that and an other to my Daughter Nicolls which I finished Yesterday (tho' I had begun it to her upon the 20th of April) and inclosed them to Lt Amphlett of 39th as it is expected He will go in a Boat to Farro this Evening. The Col: had a Walk to Rosia this forenoon, did not come home till near three, which according to Custom Tired him, and he was very much out of *Sorts* in the afternoon.

Mem^{m}· It was an Unpleasant afternoon. My Leg has been in a good deal of pain all Day. N.B. Every Day there are children Dieing with the Small Pox and also a very bad Fever. The Man of the 39th is to be Executed on Monday. The Col: very much *disturb'd* in Even. My Leg grew Violently bad at Night, obliged to be carried by all three Women to Bed.

Fry 5. Easterly wind. Lt Amphlett went last Night. Find myself very indifferent indeed, but for many reasons resolve to keep up my spirit if possible. Our little Daughter Seems very heavy and Dull to Day. N.B. I had been keeping her upon a Low Diet &c, &c, and she has taken three Preparatory Pills. She seem'd feverish at Night. The Colonel staid at home all afternoon and Seem'd more Composed, tho' very Low. Not quite so Lame myself this Evening.

Saturd 6. Easterly wind, exceeding Warm Day. It is Dreadful to hear the Number of Children that are Dieing. Charlotte very Heavy and Dull all Day, not able to hold up her Head. We are exceedingly Anxious, indeed I am quite Miserable from Fears. This afternoon the Enemy had a very grand Review, and keep up a Sort of Fight for two hours, with Horse and foot, taking Possession of all their Neighbouring Hills. It seemed to hurry the Garrison a good deal. The Gov^{r} at our house a long time this Day, looking at planns and in Conversation with the Colonel. The Col: and he went to the Castle and Lines afterwards. Some new Work is going on there. Charlotte very hott at Night.

Sund 7. Easterly wind. The Col : up at 4 oclock and out with the Genl, did not come home to Breakfast. Abundance of Children Dies with the Small Pox. Charlotte very bad and sleepy all Day. This is the 2nd Day she has been so ill. On each side of our House and Directly opposite three very fine children have Died since Yesterday after being 9 Days bad. Serjt Grant's little Girl died this Day of the Small Pox, about the 9th Day. The kind of Small Pox now chiefly going is a very Dangerous one. Doctor Baynes seems to think our child will get it now, indeed it seems an absolute Certainty as it is in every House in our Street, and in the opposite Door. The Col: and Mr Holloway Dine at Capt Vignolles. Charlotte very ill

Digitized by Google

7th May, 1780. in Evening. A Flagg of Truce from Spainiards today and a parley from them yesterday, Just before the Firing. Find myself Under the Necessity of forcing all my Strength in order to keep up, as I fear I shall have a call for all my Exertion. Towards Night the Child grew Violently bad and inclined to Startings. I greatly fear for fitts. She keeps calling for me chiefly. She was Bath'd in Warm Water.

Mond 8. Easterly wind. Charlotte had an exceeding bad Night and is quite Delirious to Day. Dr Baynes has no doubt of its turning out the Small Pox. In the Evening We observed some Spotts coming out, and she grew more cool and composed. She is kept in the Air, and Drinks Cold Drink, chiefly Toast and Water.

Tuesd 9. Easterly wind, very Warm Weather at this time. The Enemy very quiet. Our Child going on in a good Way. Seems as if she would have a good sprinkling, tho' Doctor Baynes says they will be of a good kind.

Wed 10. As the Enemy was tolerable quiet now and as Nothing very Essential occurred, I was not so Anxious to set down every little Movement which they made in loading or Unloading Small Boats which were Daily going backwards and forwards to the Orange Grove. My chief attention is now to my Dear child, who thank God goes Well on.

Thursd 11. Going on well, but very sore, and bad Nights, Still every thing appears well. She was very patient, tho' in a good deal of throbing pain.

Fryday, Saturday and Sunday. In the Same Way. Her Nights very Restless, Notwithstanding her taking opiates. On Monday they were at the height and highly Inflamed. On Wed they all turn'd and on Fryday took Physick. All the next week continued doing Right and had hardly any Second fever which is common upon the Turn. Everything was over even to the last of her Physicking, and she was put into a Bath of Warm Water and Herbs upon Saturday Evening 20th May. We have great Reason to be thankful for this Blessing; as during the Course of this last fortnight, not less than 40 Children have Died of this Dreadful Complaint; and also Soldiers,* and the air is now quite full of the bad Infection. A very Dangerous fever is also in the Garrison. All this time Every Means have been tried to obtain the Govrs Leave to Innoculate, but to no purpose. Every Body appears Unhappy, and are Dreading the approaching Warm Months. Not any fresh Provision comes near us now; So that we are badly off indeed.

Sund 21. Easterly wind, a fine Day. I went out to the Mount with the Child for the first time. It was a very Warm Day. Took a Ride after dinner to Europa. Drank Tea at the House in Town.

* The two-volume version of the diary says "More than 50 English Children have Died and Several Soldiers besides Inhabitants."

Digitized by Google

The Col : not very Well Just now. A Man of the Artillery fell down at Europa and Died as they were bringing him into Town. Several Gentlemen here in Even. My Maid Elizth Dixon taken not well.* 21st May, 1780.

Mond 22. Easterly wind, fine Day. Took an Airing to the Southward after Dinner, with Mrs Phipps who return'd to my House. My maid ill, but as We had all the Reason to suppose she had the Small Pox some years agoe, so we had not any fears. Abundance of people ill with the Small Pox. Every Day 5 or 6 Buryings, and every body Alarmed and Unhappy on that account.

Tuesd 23. Easterly wind. Charlotte quite well. The maid much Worse, a high fever. Doctor Baynes is as attentive to her as he was to our own child. The Col : out in Evening. Not well myself.

Wed 24. Easterly wind. No fresh meat kill'd in the Market. Doctor Baynes pronounces the Maid's Complaint to be the Small Pox. Great Uneasiness on that occasion. Thinking she had had it long before, therefore she was no ways prepared. We put her into a most charming airy apartment.

Thursd 25. Easterly wind very Strong. We are greatly Distresst in our family. The Young Woman very bad. I am particularly hurt at it as she now wishes She had been Innoculated. I am too much distresst to keep any publick Journal. Indeed it does not become Necessary, as most things remain in the same Unpleasant Way, the Spainish Admiral doing his Utmost to keep up the Blockade. However We sometimes get In a Boat with a small supply. Every thing at this time as Dear as ever ; nor is there any method taken to have it otherwise. The Govr says he has not any objection to have the Fresh Meat as dear as possible. It is not very easy to know his Reasons for it,—Contradiction only ! We kill'd a fine sheep this Day ; sent a Qr to Genl Boyd. The Rest was used in our House. We had Company the Rest of this Week. We are now obliged to kill a sheep when ever We wish for Fresh Meat ; which is not of half the Use to the family as it would be in Cooler Weather. We therefore now Exchange with General Boyd's family, each of us having Settled it not to kill Sheep together.

From *Thursday 25th of May to Thursday 1st of June*, Nothing happened in the public Way. Our Servant Maid is past all Possibility of Recovery. Every Means is try'd but we find it will not Do. Men, Women, and Children Dieing every Day and the Utmost Distress now appears in every Body. The air is full of this Cruel Infection. It is to be wished that the Innoculation had been allowed. That would have stop'd this Weeks agoe.

June the first. All the Same Dreadful Situation in our House. I did not Stir out. Our Clergyman, Mr Logie Died about this time. The Weather most Violently Hott.

* At the end of the MS. volume is a full journal of the progress of this maid's illness.

Digitized by Google

2nd June, 1780.

Fryd 2nd. Easterly wind. The whole Family indisposed and in trouble. The Colonel went to the Mount, and staid to Breakfast at Colonel Trigg's, also He Dined there; a very great change in the Maid for the Worse, just at half past one. N.B. From that instant there Remained no possibility of saving her, as she continued in a Dieing State.

Saturd 3. Easterly wind. Still Worse and Worse. Find myself very Lame. Baynes here as usual. At Noon she Seemed going, but Recover'd again.

Sund 4. Easterly wind. King's Birth Day. The Govr received the compliments of the Garrison upon the Grand Parade at Guard Mounting,—42 Guns Fired at one oclock, and all the Field officers, the Staff and the Navy Din'd with the Govr in his Garden. This was all the Ceremony observed on this Day!

At 20 Minutes before 3 all was over with our Maid Servant, upon the 15th Day from her being taken ill. It is a Most Unwelcome Circumstance and has greatly affected the Colonel; I am not able to tell what I experience. I was exceedingly ill and hardly able to move.

Mond 5. I went out to the Mount, took the child and Mrs Rogers, staid there till Evening. She is quite hearty and well; Seems Much to Miss her Maid and says she knows what has happened. She is old enough to know all that has pass'd. Charlotte was five years old in March.

Tuesd 6. Westerly Wind. Bustle and hurry in the House and many Unexpected Difficulties occurr'd, particularly relating to our Servants. In the afternoon the Col: sent to our Servant Man James and Discharged him at that time; the Man's children were in the Small Pox.

More and More bad accounts of the fatal Effects of the Small Pox, and Many Severe things said in consequence. It cannot be Wonder'd that the Lower Degrees of People should be much hurt at all these bad times, their Provisions so bad, Nothing to be got to assist them or their poor familys, and the Losing so many fine children, has been a heavy Stroke upon them, but We hear that a great Person in the Garrison says he thinks it a fortunate Circumstance to those Soldiers who have Large familys to Lose three or four Children!

Wed 7. This morning at half past one the Garrison were alarm'd by the appearance of some Fire Ships coming over from Algezira. The Drums beat to Arms; and the Garrison fir'd from every part of the Line Wall where they advanc'd. There was 9 in all. Most fortunately for Us the wind faild and they were obliged to light these Ships Sooner than they meant. They were all driving towards the back of the Rock. It was a most Grand tho' Alarming Sight as they burnt with great Violence. It seemed to me just so Many Moving Mountains of Fire! Every Regt was at their Alarm posts and it was generally

Digitized by Google

expected the Enemy would Fire from their Lines. I little expected such a Shock but I believe I am not Born to partake any very Common Fate; otherwise I must have long since ceased to Exist, considering all I have experienced. My heart now seems totaly full of Concern and Vexation; my bad State of Health has rendered me Miserable. Nothing but Women Servants about me. The first Moment of the Alarm the Colonel went away from the House. To hear the Drums beating, the Noise of the Guns from the Garrison and all our Ships, together with the bursting open of the port holes in the Fire Ships, was beyond the powere of my Pen to express! I was actually Stupid with Fright,—and at that Dead time of the Night also,—and Circumstanced as I and this whole family were then,—it realy was Distressing. I was even then glad to think it had not happened a few Nights before; as it would have added to our Concern if the poor Woman had been Sensible of the Circumstances. 6 of these Fire Ships ran on our Rocks and 3 were drove behind the Mountain and got away. Our Men of Wars Boats and the Ordnance Vessels behaved remarkably Well and very Cool. The Vessels continued to Burn all this Day. The *Enterprize* was the first who gave the Alarm of their coming as it was the Guard Boats from that Frigate which Hail'd the Spainish Boats which Were coming with the Fire Ships. The English officer ask'd what Boats and Vessels? they answer'd Beef Boats from Barbary! He told them He did not credit it and Instantly went on board the *Enterprize*. The Frigate fir'd one Gun, and not being answerd, they Fired as quick as they could, upon which the Enemy Set Fire to the 7. There were 2 at a considerable Distance, but had no Effect. The bustle lasted till near four and then the Regts were all Dismiss'd. It rained Smartly about 7 which greatly pleased Us; but the 2 Largest Fire Ships continued on Fire all the Day. One was Drove near to Rosia Bay where the *Panther* Lay, and got In between her and the Shore. It was very Evident the Enemy meant to set fire to the *Panther* and to the New Mole. Thanks to Providence They were Disappointed. May they always be So. I was, as well as many others, much affected with this unexpected alarm. Col: dined out. Mr Holloway with me. 7th June, 1780.

Thursd 8. Westerly wind. All quiet from the Enemy. Find myself greatly indisposed and very Low all Day. Had a little particular Conversation with Mr Holloway,—not of any use after all.

Fry 9. Westerly wind. Still very Low and ill. Two or three boats arrived from Tangier, brought letters and News papers. N.B. Not any for Us. *The Man's* child Died.

Saturd 10. Westerly wind. All the Same in the Camp &c. Very ill. Settled to dine at Mt to Morrow.

Sund 11. Westerly wind. It began to Rain about 8 in the Morning, continued to do so till Noon. It then cleared up and I went in the chaise to the Mt. Was very ill when there and could not Walk

Digitized by Google

11th June, 1780. out. Return'd at Nt. A good many in evening. 2 Market Boats from Tangier; Beef and Mutton.

Mond 12. Westerly Wind. All quiet in Camp. Worse and Worse in the Small Pox. Have had 3 exceeding bad Nights and am still ill. Take a Ride in afternoon to Europa, took 2 Miss Phipps who Drank Tea with me.

Tuesd 13. Easterly wind. All the same Uncomfortableness. The Enemy took a Setee* coming over to Us with Provisions. N.B. This was contradicted afterwards. Not very Well.

Wed 14. Easterly wind. Find that all the Ships are gone from Algezira and that Barcelo has Hoisted his Flagg on board a Xebeque. He went behind the Mountain last Night. I wrote this Day to my Son and to my Sister.

Thursd 15. Easterly Wind. The Ships attempted to sail last Nt but was obliged to Return as the wind came about. I therefore sent an other letter by Mr Colvill to my sister. N.B. Those I wrote yesterday went in a public packet from the Convent, in a Boat to Farro. Colonel Green has also sent letters by Col Gledstanes, as I did one to Capt Nicolls by Capt Ormsby who went in the same Boat with Gledstanes. The 3rd Mate of the Highland Regt Died.

Fry 16. Easterly wind. The Boat made an attempt to go but was obliged to return. Col: at Dinner at Col: Ross.

Saturd 17. Easterly wind still. Changes making in the 12th and 73rd Regts. I write a long letter to Capt Nicolls and sent it by Capt Ormsby. He has sold to Lt Colt of 73rd for twenty four hundred pounds. Capt Mackintosh's Lady (73rd) Died suddenly this Day. Colonel Gledstanes goes home as is said upon account of his ill State of Health. Grow very ill in the Evening and quite Lame. Mr Cuppage call'd here in afternoon.

Sund 18. Easterly wind. The Boats not gone. The Col: Breakfasted at the Mt. I went in the forenoon to pay some Visits in Post Chaise, and afterwards to Dine at the Mt, Return'd in Evening.

Mond 19. Easterly wind, but not Strong enough to take out the Boat. Col: at the Mt in afternoon to meet the Genl. A mistake in some Money Matters; the Col came home in very good spirits, having had a pleasant Walk with the Genl. Find myself not very well.

Tuesd 20. Westerly wind. Very Warm now. The Colonel Walking in King's and Prince's Lines with the Govr to Day. He dined at Convent, Mr Holloway with me. Some Spainish Engineers seem'd Busy on the Beach taking a Survey. A Boat arrived from Tangier brings Word that the Spainiards had taken an English Vessel bound for this place from Under the Guns at Tangier. This hurts us a little. Find myself ill at Nt.

* A small sailing vessel.

Digitized by Google

Wed 21. Westerly wind. Col breakfasted at the Mt; Busy about taking in some more ground to Improve, dined at home. 21st June, 1780.

Thursd 22. Easterly wind. Dull looking Morning. Go out to the Mt after Breakfast, take Kitty Phipps, went to the Hospital, dined at Mt and came home in even. This Day it was in Orders that the Assisting Engrs and officers employ'd as assisting Overseers should be dismis'd upon the 24th Inst. Boats for Farro go this Evening, and a Leghorn Ship, on board of which was Mr Colvill.

Fry 23. Easterly wind. Find that one of the Boats for Farro is gone, and also the Leghorn Ship. Col Gledstanes and Capt Ormsby went in the Boat; Mr Colvill in the Ship. A Boat is going away to Farro this Evening, call'd the *Fox* belonging to Merchant Andersen by which I wrote a letter to My Sister; and sent it to the Convent, being resolv'd to try all opportunities. Hear that the Enemy is making some kind of Defensive Work upon their Coast, which looks as if they were alarm'd for themselves. A small Boat arrived this Day from Minorca, left the *Porcupine* Frigate there, brings Word that the Garrison was under some fear of being besieged, and that they had no Supplies from any where. This Boat brings news of Some Gun Boats coming down here from Majorca.

Saturd 24. Westerly wind. This Day at Noon Several large Xebeques and one Frigate came from Ceuta, and in a very Impertinent way came near the New Mole. The *Panther* and *Enterprize* fir'd and the *Enterprize* sufferd from the Blowing up some combustibles on board, 15 men Wounded. I went to Mount Pleasant at this time, with an Intention to Remain out for some time, my Health being very poorly and I am willing to Try every possible Means to be Well at this Sickly Miserable Period. Came up in very great Dejection of spirits, fear I shall soon feel the fatal effects of it. Greatly is every family hurt at the Daily Misery of the poor Dieing Children.

Sund 25. Easterly wind. Settling myself at the Mount. Heard no News.

Mond 26. Easterly wind. All pretty quiet. Many Boats now at Algezira. Am very ill all Day.

Tuesd 27. About half past one this Morning we were alarm'd by a Firing in the Bay. I got up, and my Windows at the Mount afforded me the Means to See much more of this attack than I expected or Desired. It was from Boats of a particular Construction, of which indeed we had Received a Sort of Information from Minorca. They each Contained one Gun and a Large Number of Men. They evidently were attempting to destroy the *Panther* and the Ships in the New Mole. It was exceedingly dark at the first and as they were low in the Water could not be distinguish'd except from the Flashes of their Guns. The *Panther* was Laying in Rosia Bay (the same station as when the Fire Ships came) and her Stern was towards

Digitized by Google

27th June, 1780. the Boats when they first fir'd. She afterwards changed her situation, trying to bring on a Discharge from her Broadside. The frigates and other ships fir'd as did those Batterys that bore upon them from Bonna Vista, New Mole, Rosia, and every where was possible to be of any use. The 2 Regts that were at the South Barracks turn'd out, the firing continued till past 2. We could now tell with certainty the Number of Boats. Some of their shot came on Shore. One fell between the Vineyard call'd Picardo's Garden and the South Pavilion; one very near to the Centinel at the Grand Magazines. As the Day advanced they all disappeared. They are very Low in the water. By 4 oclock all was over; and no hurt done at all. We were all a good deal Alarm'd. From this time and for many Nights after we were constantly alarm'd by shot firing; sometimes by the Frigate, mistaking the Watch Boats, sometimes from the Enemy over at Algezira, and this Month of June ended in Nightly expectations of More Boats, as it was now well known they mean to burn or destroy the *Panther* but we hope they will not Succeed.

Saturd July 1st. All quiet from the Enemy. Find myself growing exceedingly indisposed. Nanny Redway came to our Family.

Sund 2nd. Still ill; pains seemingly coming on; and a great Weakness all over my whole Frame; The *Second* Child Died—very sorry. Number of Signals from over the Way, and all observed with great exactness by the Camp, Queen of Spain's Chair, &c, &c. Between Sunday the 2nd and Monday Morning the *Panther* sailed. It was not in the least Suspected, but no doubt was in consequence of those Gun Boats having so plainly shew'd their Intentions to Destroy that Ship. On Monday Noon a Row Galley came over from Algezira and plainly discover'd the *Intent*, which was to look if the *Panther* was in the Mole or if actually gone. It was Universally believed that Admiral Barcelo was on board in a Disguise. They came by much too near and in a very insulting Manner paraded about. It was plain to be seen that a person in a Fisher Mans Dress was the whole time looking through a Spy Glass; as Many of our officers were doing the same. He seem'd to be making particular observations, sometimes standing up. This Person was either Barcelo or some officer of Trust. Our Frigate and an other Vessel fir'd at the Galley. She kept Her Colours up the whole time and when she had sufficiently amused herself went off. A Night or two after this More Boats came over. It was pretty clear at their first appearance, and I plainly discover'd 6 Gun Boats. We fir'd very heavily at them, and they had Repeated Signals made from Algezira and from Point Negro &c which they obeyed, and after being about an hour in the Bay disappeared.

The Rest of this Month little Essential occur'd. The Same Uneasiness proceeding from the Blockade. The Enemy are tolerably quiet at Nights, only taking care not to allow any thing to go out of

Digitized by Google

to come In to Us. Provisions are dreadfully Dear and exceeding Scarce. Very bad for Sick Families. 2nd July, 1780.

Tuesd August 1st. Easterly wind. Had a very bad Night, the pain intolerable in my Hip and Back. Send In to the Col: who informs me that Baynes has promised to come out in evening, that the Col was to dine with Col Picton. Battle of Minden Day, celebrated by Col Picton, 12th Regt. All Ended in perfect Harmony. Col: came up in evening in very Easy Temper; Baynes came. In great deal of pain all this evening. Dinah came up likewise, ill with a pain in her Head and face. The wind came Westerly about Nine oclock and Blew hard. Great scarcity of Provisions. About this time Major Horsfall of 72nd sold his Cow for Fifty Guineas and a pint of milk every Day!

Wed 2. Westerly wind. Had a very painful night, could not stir myself. Take some of the pills for the first time. The Col: did not come out this Day. Betty went into Town in the Evening as George is not well.

Thursd 3. Westerly wind. Still exceedingly bad. Dinah had a Blister &c. About Noon We observed at the Gut's Mouth a Sort of Engagement between some Galleys and a Large Boat or Setee. However they were so distant We could not tell, but it is too much fear'd it is the *Fox* pacquet Boat. Whatever it was they have taken to Tangier we think or to Cadiz.

Fry 4. Westerly wind. A Setee got In with great difficulty from Minorca. She was closely follow'd by Row Galleys. She brings a Small Supply of Wine, Honey, and a few pigs. We hear about this time that the Ports in Barbary are totaly shut against Us! The Moors will not shew the least inclination to assist us. On the contrary they allow our Vessels to be taken in their Harbours. This We learn by Means of Several Parleys which have come In of late and in particular of an English Vessel's being taken a few Days agoe as she was going into Tangier, that the Passengers are gone to Algezira and that there is among them an officer of the 56th Regt and a Merchant and his Wife who are to be sent in a Flagg of Truce in a few Days.

From this Day till Saturday the 12th nothing particularly Worth Mentioning occurr'd.

Saturd 12. Westerly wind. Just after our Morning Gun Fir'd there were Signal Guns and Rockets fir'd from Caberitta point and in half an Hour a Brig appear'd coming round the point. She was chased by 4 Small Galleys. She fir'd two Guns to Us by Way of Claiming our Assistance. She was Directly known to be a Brig belonging to Merchant Mackellar, call'd the *Dolphin*, from Lisbon. He has long expected her, is Loaded with Wine, Oil, Sugar, &c. The same Vessel had been a long time in Tangier Harbour and has been twice fortunate enough to get In here with Supplies. She now

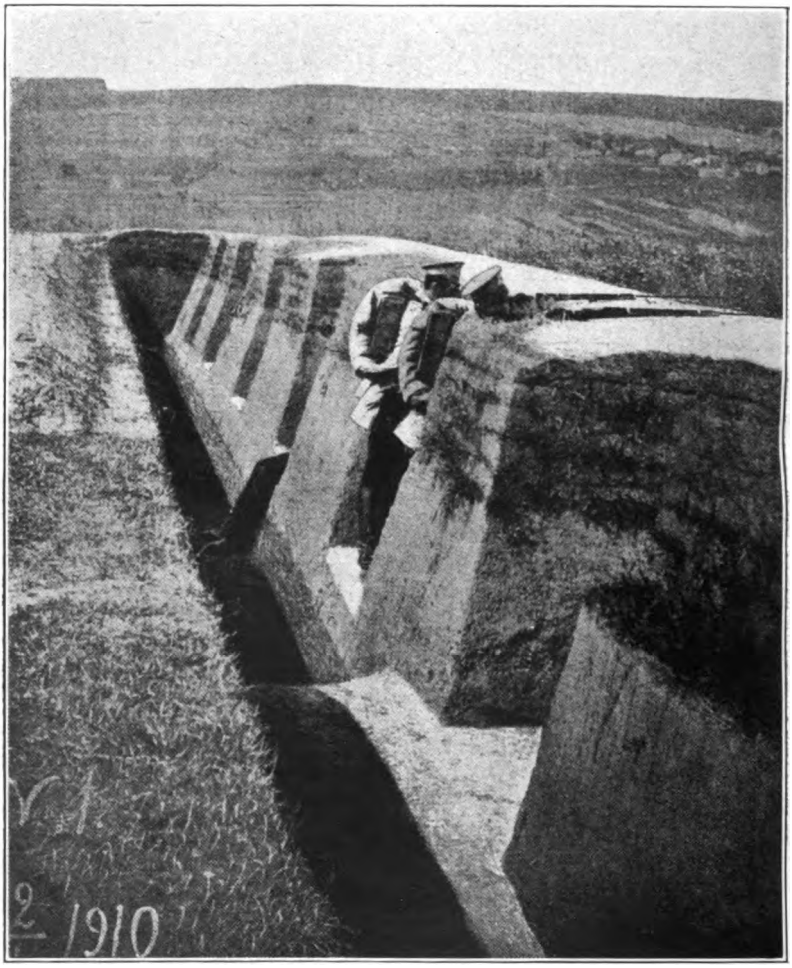
Digitized by Google

12th August, 1780. saild In with a fine wind at the Day break. Unluckily it faild at half past 4. She made for Europa. There our Batterys fir'd and from Bonna Vista, but not one shot hit the Galleys. We fir'd one Shot from the New Mole Head to encourage her. She came at last very near our guns, and We flatter'd ourselves she was out of Danger, as the 4 Small Galleys seem'd Shy of our Batterys. At this Instant 2 very Large Row Galleys came pouring down from Ceuta. This encouraged the others, so that to the Universal Concern of the whole Garrison they Boarded Her. She would not Strike. I saw the whole Manoeuvres from the very instant she first came round, saw all Her sails shot away, the Grape Shott flying all over her Rigging. The last shot carried away her Lower sails and Yards, then it was easy to Board Her, and I plainly saw the first Spainiard get on Board, it is impossible to express the discontent of the Garrison on this occasion. The *Enterprize* was in the Mole, but every Body expected all the Boats would have been arm'd and sent out, which if they had when the first signals were made from the point it is beyond all doubt we should have got Her Safe In. It certainly is the most Unpleasant Circumstance that has happened to us, and has occasioned Many Severe things to be said against our *Navy Folks*. No Wonder. We dread to hear the fate of the Captain and Crew. They must have Suffered We think. She Lay to for half an hour after they took Her, and as it was a Dead Calm and she was much hurt they Tow'd her over to Algezira. It is supposed to be an Essential Loss to this Garrison as we are in Want of every Commodity which we know she had on board. Mr Mackellar says it is a very great Disappointment. He hopes his share was insured.

(*To be continued*).

Digitized by Google

Digitized by Google



The 'Nest' or Recess Trench (full size and profile).

Digitized by Google

TRANSCRIPTS.

"NEST" (OR "RECESS") FIRE TRENCHES.

(*Précis* of an article, by Capt. Modrakh, of the Russian Engineers, published in the *Injenerni Jurnal*, March, 1911, pp. 293—311).

THE great importance of spade work, both in attack and defence, is now universally admitted. The difficulty lies in the elaboration of a suitable type of fire trench capable of satisfying the required conditions; of which the most important are the following, viz.:—

1. The plan and profile must be such as shall admit of gradual development; at the same time affording the maximum amount of cover and strength at every stage, and *especially during the earliest stages* of its construction.
2. There must be adequate cover from enfilade fire.
3. The accommodation should provide for men acting in pairs; the file (and not single men) being regarded as the primary infantry unit.
4. Strong frontal fire must be combined with a wide horizontal range, and close adaptation to the ground.

The construction of "nest," or recessed, trenches was tested practically during certain musketry courses for officers in the summer of 1910.

The scheme provides for the construction of "nests," or recesses, (each having a frontage of 2 paces, and accommodating 2 men), at intervals of 2 paces.* Such recesses may or may not be connected by a small trench in rear for purposes of communication, but only if time permits. Such a trench might be deepened to a depth of 4′ 8″. The advantages claimed for this arrangement are (*a*) the initial stages in the construction of such cover can be completed much quicker than is the case with the (Russian) regulation pattern of trench; (*b*) the horizontal field of fire covers an arc of 120°, as against only 60°; (*c*) complete cover from enfilade fire; (*d*) the fact of two men being together more than doubles the value of each man, due to the moral support each receives from the presence of his neighbour. The strength of the firing line (one man to 2 paces) remains the same as that allowed for in the existing (Russian) form of trench.

A comparison of the *Photo.* with *Fig.* 1 (reproduced from the *Russian Official Manual of Field Entrenchment for Infantry*, 1908) will explain the difference between the proposed and existing forms of trench (specially with regard to enfilade fire).

* The Russian pace varies from 28 to 35 inches, but in this article is generally taken at 1 arshin or 28 inches.

Digitized by Google

Similarly, a comparison of *Figs.* 2 and 3 will show the enhanced field of lateral fire, afforded by the proposed recesses.

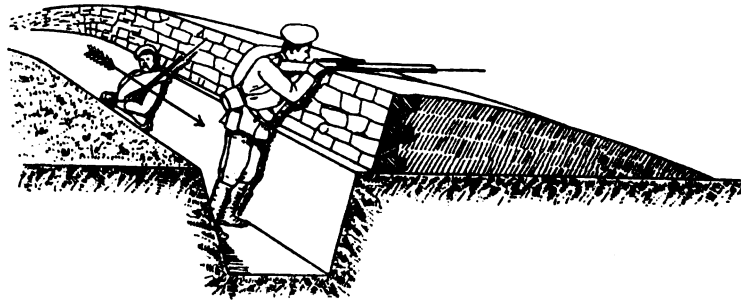


FIG. 1.—*Fire Trench (Russian Regn. Pattern).*

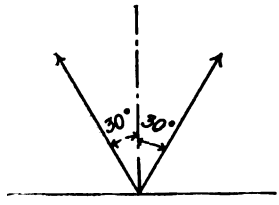


FIG. 2.—*Lines of Fire in Ordinary Trench.*

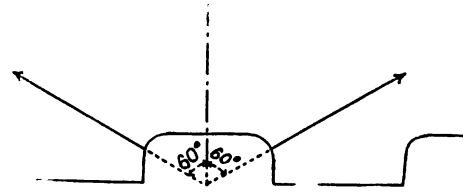


FIG. 3.—*Lines of Fire in Recess Trench.*

The time and labour required for the construction of these "nest" trenches is considerably less than in the case of ordinary or normal trenches, owing to the amount of earthwork saved by the ground untouched in the intervals (2 paces) between the "nests." This economy of time and labour is specially marked in the early stages of the work, when the cover afforded by the new form of trench advocated is very superior to that of the existing form of trench.

1. The regulation pattern trench for cover lying down, as distinguished from the individual rifle "pit" of similar dimensions, should be abolished. It takes nearly twice as long to construct as a "nest" in which men can fire sitting (a much more comfortable position); while the cover afforded (specially from shrapnel) is much less effective. Until it is completed to its full width the man's position is uncomfortable and exposed, and, even when finished, the man must lie on the damp earth.* Moreover, the lying-down position offers a large horizontal target exposed to shrapnel.

With a view to obviating this exposure of men lying down, by provision of better cover from view (though not from fire), a previous writer in the *Injenerni Jurnal* (May, 1910) proposed prizing up the turf (as shown in *Fig.* 4). Having some such course available the construction of a "nest" can be begun 1 pace in rear of it (*Fig.* 5) throwing the earth forward in such a way as not to spoil the raised turf. Each man (of the file) would dig in turn his own half of the "nest" while the other man lies down and fires, if necessary. The hole thus excavated would have a frontage of 2 paces (about 4′ 8″) with a diameter from front to rear of

* The writer considers that the prone or lying-down posi ion is not good for prolonged fire, owing to the discomfort of the rifle's "kick" on the man's collar-bone.

Digitized by Google

about 3′; allowing both men to sit or squat. The depth of the excavation will be such as to give a total height of cover of 21″ (*i.e.* cover for a man sitting); half of that amount (10½″) being excavated, and the other half in the breastwork (*Fig.* 6). The exposure to shrapnel is small, as the horizontal target presented by each man is only about 28″ square.

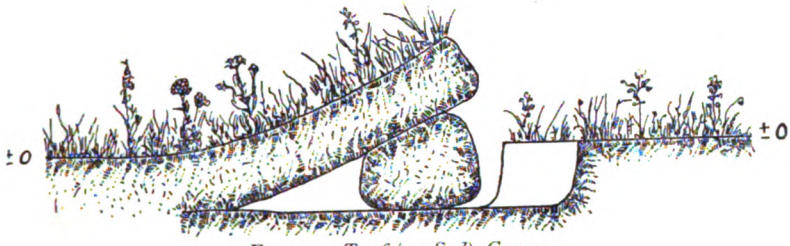


FIG. 4.—*Turf (or Sod) Cover.*

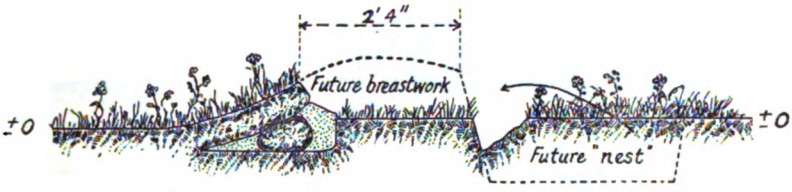
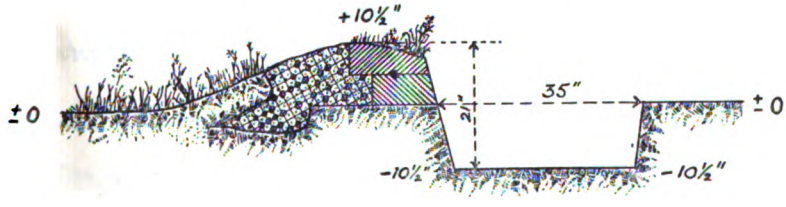


FIG. 5.—*The Beginning of a "Nest" Trench.*



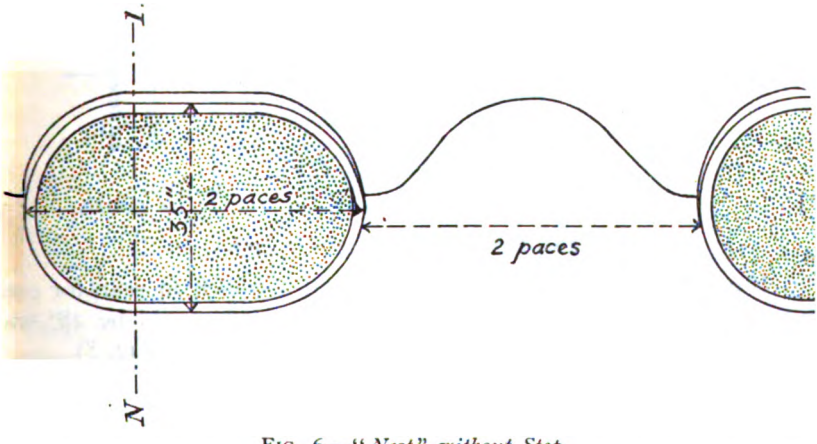


FIG. 6.—"*Nest*" *without Step.*

The amount of earth to be excavated by each man is only 4·06 cubic feet,* a task which in normal soil, with a small spade, could be finished in 13 minutes. In the case of the ordinary trench, cover lying down,

* The English equivalents of the author's figures are given, and they tend to show the tasks to be lighter than they probably would be.

Digitized by Google

the task amounts to (nearly) 5·1 cubic feet, or in the full-sized trench to 6·35 cubic feet; taking 16 to 20 minutes to complete. This advantage in favour of the "nest" form advocated is even greater than appears at first sight, owing to the fact that the area of hard surface soil to be dealt with, in the case of the regulation pattern trench, is nearly twice the size of that covered by the "nest."

2. Subsequent improvement of the "nest" trench consists in deepening the front part of the "nest" (by about 17½") to a total depth of 28", so as to provide room for the feet of the men sitting (*vide Fig.* 7).

Additional task per man	...	...	...	= 2½ cubic feet.*
„ time required	...	...	...	= 8 minutes.
Total time from commencement			...	= 21 „
„ earthwork	...	...	...	= 6·6 cubic feet.

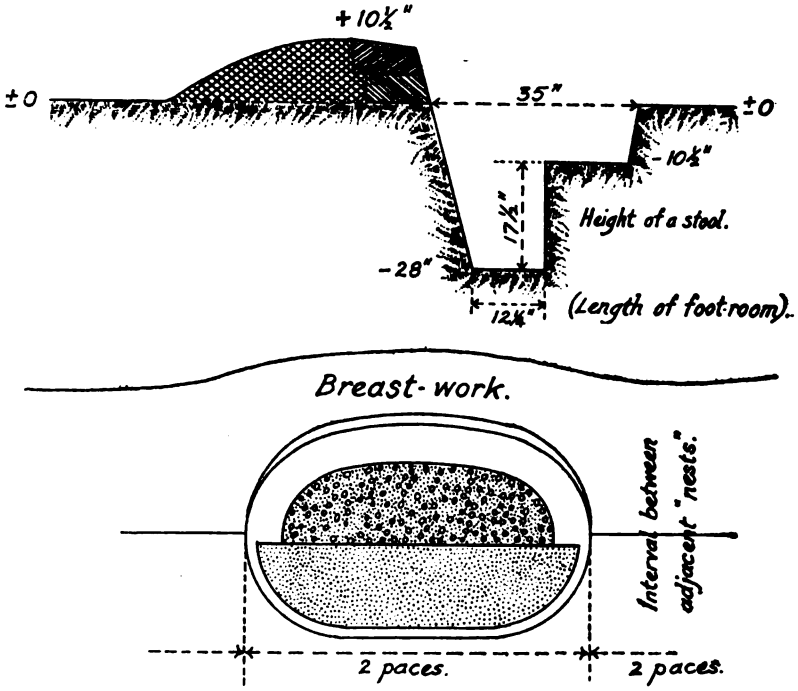


FIG. 7.—"*Nest*" *Sitting with Step.*

3. If time permits, it will be useful to add a trench in rear, for communication between adjacent "nests." This trench would be 28" wide and sunk level with the step or seat on which the men sit (*Fig.* 8).

This represents a task per man...	...	...	of nearly 7 cubic feet.
Time required		...	22 minutes.
Total time from commencement		...	43 „
„ earthwork „		...	13·6 cubic feet.

* The actual amount is nearly 3½ cubic feet.

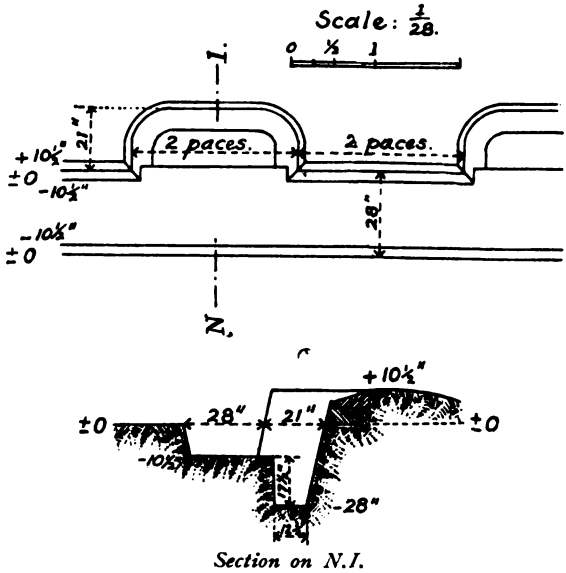
Translator's Note.—It will be noticed that the tasks mentioned here are only (*approximately*) half the amounts given in the "Comparative Table" at the end.

This discrepancy is probably due to the fact that the amounts named here refer to each man's task on a frontage of 1 pace; whereas the table deals with a frontage of 2 paces.

Digitized by Google

The regulation trench for cover kneeling requires earthwork amounting to more than 24 cubic feet, or nearly double as much as the figures given above, to say nothing of the superior comfort and convenience of the sitting position as compared with kneeling.

The trench for communication might be widened later as time may offer, but this is a matter of secondary importance—the first consideration being cover for the men firing.



Section on N.I.

FIG. 8.—"*Nest*" *Sitting.*

4. The following further improvements would provide cover for men standing, with a small trench for communication purposes (*Fig.* 9).

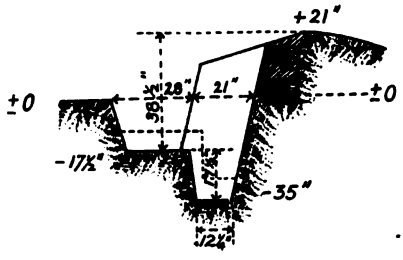


FIG. 9.—*Proposed Cover "Standing," with Small Communications.*

First, the bottom of the trench (on which the men's feet rest when sitting) would be sunk another 7" (to a total depth of 35") and the breastwork raised to a height of 21". Then the trench in rear (for communication) would also be deepened by 7"—to a distance of 38½" below the crest line of the parapet.

This represents an additional task of	...	8·64 cubic feet.
Which would be completed in ...	...	27 minutes.
Total earthwork from commencement	...	22·2 cubic feet.
„ time „ „	...	1 hour 10 minutes.

Digitized by Google

Comparing the proposed form of cover thus improved, with the regulation trench for cover standing, we find that the earthwork of the latter amounts to 39·6 cubic feet, requiring at least two hours to complete.

5. Further improvement would be the work of a second relief, and would consist in deepening the communication trench down to the level on which the men stand when firing (*Fig.* 10 and the right-hand portion of the *Photo.*). Its clear width at bottom would be about 14″, which would be ample, as the firing line (in their recesses) would not block the way, as in the case of the ordinary trench.

This work represents a task of (nearly) ...	4·1 cubic feet.
Executed in	13 minutes.
Total time occupied in construction (1st and 2nd reliefs)	1 hour 23 minutes.

Thus it only takes 40 minutes to convert the cover "sitting on step" into really good cover standing.

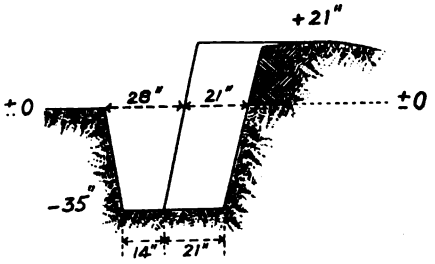


FIG. 10.

6. On the defensive, or at a distance from the enemy, when plenty of time is available, it would be possible to provide for additional comfort, and to deepen the communication trench to a depth of nearly 4′ 4″ or some 17½″ below the level on which the men stand when firing.

In this case the communication trench would be 14″ wide at the foot.

The amount of earthwork per man would be	68·1 cubic feet.
Requiring in normal soil with a small spade	3½ hours.
Or with a large spade	2 hours 40 minutes.

In the ordinary type of trench giving cover standing, the earthwork amounts to more than 90½ cubic feet, which would take 4¾ hours to complete with a small spade or 3 hours, 33 minutes with a large one.

It will be seen from what has been said above, that at every stage of its construction the "nest" form of cover advocated represents a substantial saving of labour and time.

7. In the *Photo.* the legs of men sitting in one of the recesses are seen exposed, though the men themselves are under cover from shrapnel fire. This can be easily obviated by narrowing the ledge (on which the man is sitting) to a width of 14″—which is quite sufficient. The soldier's legs would then be entirely within the "nest" or recess. The earthwork would only amount to 1½ cubic feet, and could be done in 5 minutes—or at any time, bit by bit.

Digitized by Google

No traverses are necessary to give cover to the firing line from enfilade fire, though the communication trench would have to be defiladed, either by means of traverses, or by its trace* (*Fig.* 11).

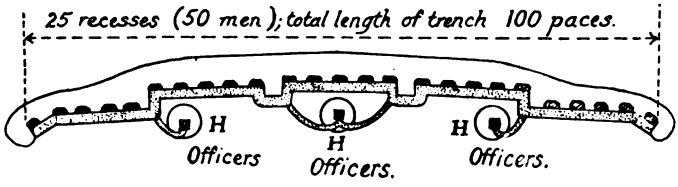


FIG. 11.

Similar "nests" should be constructed for officers, some 4—7 paces in rear of the firing line and connected therewith by small communication trenches (see *Fig.* 11—H.H.H.).

The annexed comparative table shows the amount of time and labour required for the successive stages in the construction of the various forms of cover referred to above. The same conditions have been assumed in all cases, viz.:—a frontage of 2 paces per man, average soil, and a small spade.

The last column, "saving of labour" has been worked out from the minimum amounts of labour required for the type of cover referred to.

It is important to notice the great saving of labour at the initial stages of the work. The types of work to which most importance is attached are Nos. 3 and 6, of which the first is specially suited for use in the attack, and the second for employment on the defensive. Nos. 4 and 5 are intermediate forms suitable for the hasty entrenchment and defence of a position.

The times given in the table, can only be approximate, owing to varying conditions of soil, etc., but they will suffice for purposes of comparison.

In conclusion it is urged that the proposed form of cover is greatly superior to the ordinary type of fire trench, and is more in accordance with the requirements of modern fighting.

* Attention is also drawn to the small modification shown in the profile of the superior slope of the parapet. It is claimed that the small inward slope or curve suggested, adds to the comfort and convenience of firing over the breastwork.

Digitized by Google

COMPARATIVE TABLE.

Trenches of Normal Regulation Type.			"Nest" or Recess Trench Advocated.			Saving of Labour in the "Nest" Type Advocated. % ‡
Stage of Construction.	Earthwork, Cubic Feet.	Time taken in Construction.	Stage of Construction.	Earthwork, Cubic Feet.	Time taken in Construction.	
1. Individual rifle pit (cover lying down).	5·08 cubic feet (+ superfluous turf).	16 minutes* (or more).	1. Separate "nests" (cover squatting without step) (*Fig.* 6).	4·06 cubic feet.	13 minutes.	25% (or more).‡
2. Trench (cover lying down).	9·5 cubic feet.	30 minutes.†	2. "Nest" (cover sitting on step) (*Fig.* 7).	6·6 ,, ,,	21 ,,	43%
Trench improved (widened).	12·7 ,, ,,	40 ,,	—	—	—	90%
3. Trench (cover kneeling).....	24·1 ,, ,,	1 hour 16 minutes.	3. Line of "nests" (cover sitting on step) (*Fig.* 8).	13·6 cubic feet.	43 minutes.	78%
4. Trench (cover standing) (*Fig.* 1).	39·6 ,, ,,	2 hours 5 minutes.	4. Line of "nests" (cover standing, with small communication trench) (*Fig.* 9).	22·2 ,, ,,	1 hour 10 minutes.	78%
5. Trench (cover standing) (*Fig.* 1).	39·6 ,, ,,	,, ,,	5. Line of "nests" (cover standing) (*Fig.* 10).	26·3 ,, ,,	1 hour 23 minutes.	50%
6. Trench (cover standing on step).	90·5 ,, ,,	4 hours 45 minutes.	6. Line of "nests" (cover standing on step) (*Photo* 1).	68·1 ,, ,,	3½ hours.	33%
			7. Line of "nests" (cover standing, with seat under cover from enfilade fire).	69·6 ,, ,,	3 hours 35 minutes.	30%

REMARKS:—

1. * The actual size of this type of rifle pit must depend upon the size of the man.
2. † The larger expanse of hard dried surface soil (or turf) to be dealt with in the case of the normal type of trench, causes delay and so favours the other form of trench advocated.

‡ *Translator's Note.*—These are the author's estimates.

Digitized by Google

SAND-BAGS AND THEIR APPLICATION DURING THE RUSSO-JAPANESE WAR.

Extracts from an article by Z.M., published in the June-July number of *Injenerni Jurnal.*

The war showed the extreme value of sand-bags, both in attack and defence, in field and siege warfare. On certain occasions they were an absolute necessity, as, for instance, when it was required to make cover under the heavy rifle fire of the enemy, or on rocky or frost-bound ground, or inside the concrete galleries of permanent works, or when revetting loose stone parapets in a land where no other revetting material was available.

In Field Warfare in the Attack.

The Japanese were the first to make wide use of sand-bags under these conditions.

A Japanese officer writes as follows:—"The bags used were rectangular, of a light cotton material, khaki colour, about 21″ long by 9″ wide. During the march they were carried, rolled up, either in the knapsack or cartridge bag. As soon as the men arrived within the sphere of hostile rifle fire they filled the bags with grass, hay, light twigs, earth, sand, stones, etc., and used them, when firing in the lying position, as cover from fire and also from view. During the advance they were best carried slung over the left shoulder, and when they were no longer required they were thrown away. For filling the bags, even in a cramped position, only 1 to 2½ minutes were required, if material was easily available, but if it was necessary to excavate in stony or frozen ground more time was wanted. When using sand-bags, the accuracy of shooting was improved, as the rifleman, feeling that he was behind cover and that he presented considerably less of a mark to the enemy, gained confidence and calmness from the feeling of greater safety. In stony or frozen ground where the shovel could not be used, these bags, filled with earth or sand, were used for constructing cover. When the troops were not in action but on the march or in bivouac, the sand-bags, filled with straw and weighing 2½ to 3 lbs., were used as pillows, or, without the straw, for carrying small articles of equipment, or as a protection against flies and mosquitoes."

Digitized by Google

These sand-bags, when filled with earth, weighed between 30 and 40 lbs., and, for greater convenience in carrying, were fitted with handles.

In the series of battles which took place before Mukden in February and March, 1905, many examples occurred of the use of these sand-bags in action. Thus on one occasion the Japanese 5th Division, in order to cross over a zone swept by the enemy's rifle and machine-gun fire, constructed no less than eight separate lines of trenches arranged for firing, standing and kneeling. These were all made in the course of 72 hours and were sited respectively at 1,500, 1,200, 800, 500, 400, 300, 200 and 100 paces from Russian position, and from 800 paces onwards they were made almost entirely of sand-bags, as the frozen state of the ground allowed of very little excavation.

In the operations of Oku's army further to the west, parties of infantry carried with them sand-bags already filled with earth. This they were enabled to do by having their equipment carried by hired coolies. On arriving at dawn within 1,000 paces of the Russian firing line, they lay down behind a breastwork of the bags, and after a short artillery preparation began to move gradually forward rolling the filled sand-bags before them, there being no prospect of filling them again owing to the frozen state of the ground. When they had arrived within 600 to 700 paces from the position they stopped, and threw up a continuous line of new trench, made of sand-bags protected on the outside with clods of frozen earth. In the following night under cover of darkness, having made a fresh breastwork within 300 to 400 paces of the Russians, they carried out a series of desperate attacks, all of which were beaten back from the wire entanglements. In spite of these failures they were enabled by their sand-bag breastworks to remain for two whole days in the closest proximity to the Russian lines under very heavy rifle and machine-gun fire.

Both of these examples occurred on the west side of the railway where the ground was level. In the hilly region lying to the east, sand-bags were little used, probably because the ground was covered with trees and bushes and intersected with ravines and precipices, all affording a plentiful supply of natural cover.

There were not many opportunities for the Russians to practise the use of sand-bags in the attack, but a few cases did occur. For instance, on the 1st March, 1905, in this same neighbourhood on the west of the railway, parties of the 3rd and 7th Rifle Regiments, after capturing a position, spent two whole nights in entrenching it, and here they built up the inner slopes of their parapets with sand-bags, making loopholes and, later on, even traverses. In all, trenches for two double companies and an approach 200 paces in length were constructed, and 5,000 bags were used, which were carried filled over half a verst to the position.

But the use of sand-bags in the attack is not limited to frost-bound ground and wintry conditions. When filled with earth and laid in several rows they will stop rifle bullets; when filled with grass or twigs they may afford concealment, which is protection against all kinds of fire; and by giving confidence to the men, besides rests for their rifles, they will increase

Digitized by Google

the accuracy of their fire and reduce their losses. There are however certain objections attached to their use. Weighing about 35 lbs., they cannot be carried in addition to other equipment, and if this is left behind it may cause serious inconvenience in case of an unexpected pursuit or of a retirement not exactly over the original line of advance. Again, a single row may stop shrapnel bullets, but will not stop rifle bullets. For these three or four rows ($2\frac{1}{4}'$ to $3'$ thickness of parapet) are required, so that to cover one man it is necessary to use the sand-bags of two or three others, who are thus left without protection.

Sand-Bags in Field Warfare in Defence.

On both sides the use of sand-bags was far greater in defence than in the attack. They were used for revetting slopes, making loopholes and traverses in works and trenches, and also for repairing damage caused to parapets by the explosion of common and high-explosive shells.

In the mountainous parts of Manchuria, where the ground was generally stony and often solid rock, the parapets had to be built up of fine or coarse stone rubbish, covered with a layer of carried earth. All the revetments, loopholes and traverses were made of sand-bags, the material used being the cheap American cotton fabrics of grey and other colours which were commonly worn by the Chinese.

The repairing of the so-called Railway Redoubt during the Mukden fighting is a good example of what can be done in the way of repairs to fieldworks with the help of sand-bags. Here after $1\frac{1}{2}$ hours bombardment by 6″, 8″ and even 11″ artillery, all the casemates were demolished and the parapets half levelled. On the approach of night when the Japanese attacks and bombardment were discontinued, the Russians set about repairing the damage. Owing to the frozen state of the ground and the limited time available, entrenching tools were considered to be of little use and it was decided to use some sand-bags which happened to be available in store. By the efforts of two companies 500 sand-bags were carried up to the redoubt, and with these it was possible to repair the main parapet.

Use of Sand-Bags by the Attack in Siege Warfare.

In the Kwantung peninsula where rocky ground prevailed not only in the hills but also frequently in the plains, both opponents found it necessary, when working within the sphere of the enemy's shrapnel and rifle fire, to save time and labour by making breastworks of sand-bags rather than deep trenches. These they protected on the outer side by stone rubbish covered with a layer of clay. In the provisional works which were made in the presence of the enemy, but beyond the range of his artillery fire, sand-bags were also freely used for revetting slopes, owing to the absence of timber or other suitable revetting materials in the neighbourhood of Port Arthur.

Digitized by Google

The Japanese used sand-bags in their regular saps, and also in the assault, for securing the possession of important captures, or for keeping a footing on a position where the main object had not been obtained. Their saps were pushed forward under the cover of sand-bags, barrels filled with earth, sap-shields, etc. All the parapets were crowned by high *bonnets* of sand-bags, with narrow embrasures between them, masked by curtains of khaki material. In rocky ground the parapets were built up entirely of sand-bags. In the approaches to Fort No. III. they made use of an original method of protecting themselves from the fire directed upon them from the Russian advanced positions further to the south, by making a double series of sand-bag traverses, parallel to the front, each 6′ to 7′ in height and 21′ to 28′ in length, breaking joint, and spaced at 21′ to 28′ from one another.

During the assaults on 203-Metre Hill they succeeded on one occasion in reaching at dawn the outwork which crowned the crest, but could get no further owing to the heavy fire directed upon them. As they lay exhausted on the bare slope they set to work to construct a breastwork of sand-bags which they had brought with them, and in spite of heavy losses they succeeded in completing it and connecting it with their nearest trenches, and thus obtained a *point d'appui* for further assaults. This they also did on the neighbouring 211-Metre Hill, when they had got a footing on its eastern crest. On Flat Hill they made their approaches like blinded saps with both parapets of sand-bags.

In August, when they obtained possession of the two redoubts which were situated between Forts Nos. II. and III., they adapted the interior areas of these works for protection against fire from all directions. For this purpose they built up breastworks of sand-bags and roofed them over with beams and sand-bags.

During the period of the mining warfare they used sand-bags for carrying earth from the mine galleries, for constructing obstructions when crossing the counterscarp galleries, and for the blinded saps across the bottom of the ditch.

The best example occurred in Fort No. II., where after penetrating into the counterscarp gallery they crossed it under cover of a breastwork of sand-bags, and then cut their way through the outer wall into the fortress ditch. After this, during the night, they made a covered sap across the ditch with sand-bags and joists, proof against rifle and machine-gun fire from the flanking galleries on both sides, but which however was speedily demolished by the defenders with gun fire.

In the fighting in the counterscarp gallery of this same fort the defenders put up a series of cross-walls of sand-bags for its protection. In attacking these the Japanese made a kind of movable parapet of three rows of sand-bags, in height about 4′ 8″, which they worked forward by throwing the bags in the nearest row over to the far side of the others.

Digitized by Google

Use of Sand-bags in Siege Warfare by the Defenders.

The stony nature of the soil around Port Arthur compelled the use of sand-bags in most of the fortifications. They were used in the outlying covering positions, in the defence of localities and in the temporary works, which lay within the fortress zone, and finally in the permanent works themselves, for revetments, traverses, the roofing of casemates, and sometimes in the construction of complete parapets. Both small sand-bags and also sacks from the supply stores were used for these purposes.

In the preparatory period when the fortress works were being hastily completed, sacks filled with broken stone were used instead of brick and stone in revetments. In Work No. 3, the exit from the casemated barracks into the gorge ditch was protected in this way, and also a structure which took the place of an armoured conning tower. The ramparts of some not fully completed forts and batteries, and traverses separating guns, were built up of sand-bags filled with earth. Two dilapidated Chinese *impans*, or serais, lying between Forts Nos. II. and III. were put in a state of defence by having the interior slopes of their parapets revetted with barrels and sacks of earth.

On 203-Metre Hill a great many blindages were made in the deep trenches on the summit and on the reverse slope, and were covered with beams, rails, stone rubbish and sand-bags. Many of the latter were made out of old great-coats.

During the final assaults on the permanent works, it was found necessary to provide the men manning the front parapets with shrapnel-proof cover, and this was done by building short lengths of sand-bag walling along the rear edge of the banquettes, with a roofing of thick planks held down by sand-bags on their front and rear ends.

In rear of the Chinese Wall there was a series of dug-outs and blindages, the roofs of which, and in many cases the walls also, were made of beams covered with stone rubbish and sand-bags.

In the defence, as in the attack, the works carried out under the immediate fire of the enemy could not have been done at all without the help of sand-bags. Examples of their use occurred during the preparations for the re-capture of the redoubts between Forts Nos. II. and III., and here also the communication trenches were protected, after the example set by the Japanese, by a double row of traverses placed parallel to the front, 6′ to 8′ in height, 14′ to 28′ in length, breaking joint, and 21′ to 35′ apart.

The use which was made of sand-bags in the defence of the counterscarp galleries has been already described; the successive walls were placed at 21′ intervals. Flanking protection for the ditches on the flanks of Fort No. II. was built of sand-bags, and the interior area of the same fort was broken up into sections of defence by the same means.

Digitized by Google

As material for sand-bags, it was found that cotton, hemp, flax or woollen materials were in considerable danger of catching fire, and that their use in places where water was not available was dangerous. The chief causes of fire were common shell and certain special contrivances practised by both combatants. The abandonment of Redoubt No. 1 is attributed to the blindages and sand-bags having caught fire under a heavy bombardment, and in the defence of Fort No. II. the Russians sprayed kerosene by means of a fire engine on the sand-bag crowning of the Japanese saps, and set it on fire by specially prepared fuzes, with the result that the parapet fell to pieces.

F. E. G. SKEY.

Digitized by Google

NOTICE OF MAGAZINE.

RIVISTA DI ARTIGLIERIA E GENIO.

October, 1911.

MILITARY WIRELESS TELEGRAPHY.—An article on the above subject by Capt. Bardeloni of the Engineers in the October number, contains matter of much interest.

The employment of wireless telegraphy in naval warfare, as a unique means of communication at great distances between the various units and for regulating the action of troops on land, is of the greatest importance for military operations. Neither the mountains, the mist, nor any other obstacle prevents the use of wireless telegraphy when it is desired to communicate orders or notices to others or to call for reinforcements, and in field operations, either in the plains or mountains, in sieges, or in reconnaissances, wireless telegraphy is a most useful auxiliary not in any danger from the breaking of telegraph wires. But there is more. To-day not only are reconnaissances made by divisions and detachments on the march towards the enemy, but also with the assistance of balloons, dirigibles and aeroplanes.

The author goes on to define the various means of applying the science of wireless telegraphy to military requirements.

Field Stations.—It will be more than ever desirable on the battlefield that wireless telegraphy should be used as a means of communication between the masses of operating troops and the commands on which they depend, thus safeguarding probable interruptions such as the breaking of telegraph posts and wires. It should also be possible to make use of wireless telegraphy in regions of not too great an extent, with suitable receiving and transmitting instruments.

Now, where wireless telegraphy may be of practical use is in the reconnaissances made by the exploring cavalry. What should be the characteristics of the field stations and of those for cavalry? For both cases there should be complete wireless telegraph apparatus adapted to send messages of about 100 kilometres over every kind of ground, be it mountainous or woody.

The weight of the apparatus, compatible with the energy required for the stations, should be reduced to a minimum; the system of transmission and receiving would naturally be such as to insure as far as possible the syntonization of the circuits, permitting of the generation of two or three lengths of waves, differing sufficiently from one another and to be employed indifferently according to circumstances. The mobility of the stations is of importance in both cases. For the field stations it is only

Digitized by Google

necessary that they should be able to follow the troops and the commands, and the various materials can be carried on a small carriage with trained animals, great rapidity of movement not being required; but for the stations for cavalry greater speed would be necessary.

The author goes on to recommend the use of automobiles, as the apparatus would work more usefully in the closed carriage of an automobile, than in the open. Automobiles for the stations of advanced reconnaissances are stated to have been tried with the best results, in the French manœuvres of 1909, and they have also been adopted in Germany.

Permanent Stations.—What has been said with regard to the application of wireless telegraphy to field stations is also applicable for the defences of fortified places. But the limitations are less in this case, partly owing to less disturbances in the air, and partly to diminution in the dimensions and weight of the machinery. In places where the house of the Consul is situated in a suitable locality, there would be advantages in syntonization and dirigibility so as to secure good communication with other stations, both permanent and field, which have to correspond with the place.

Wireless Telegraphy from Dirigibles and Aeroplanes.—Evidently this problem requires certain special arrangements. As is well known it is usual to communicate through the air either through earth, or through the sea, so as to make an earth as it is called, but this is not possible in a complex apparatus existing entirely in the air. Hertz has demonstrated practically the truth of Maxwell's theory that the propagation of electromagnetic oscillations happened equally if the oscillation did not communicate with the ground. Again to-day, in practical wireless telegraphy, there are discussions on the function that the earth has in the propagation of the waves, but in some cases they have fortunately succeeded in transmitting, with good results, wireless messages, although substituting for the contact with the earth one or more metallic conductors isolated from the earth, and having electric characteristics equal to those of the wire or complex wires which constitute accessories of the aerial line. The aerial is therefore said to have its *counterpoise*, and it will be necessary to recur to the system of counterpoises to adapt wireless telegraphy to dirigibles, by forming the irradiating apparatus of a long wire of 100 to 200 m. wound ordinarily around a small drum.

E. T. THACKERAY.

Digitized by Google

CORRESPONDENCE.

TACTICAL RECONNAISSANCE.

SIR,

In the December number of the *Journal* (only lately received in this distant station) is printed a reconnaissance report made by two young officers of the Corps. In view of the high praise bestowed upon it in the covering letter, it may seem presumptuous to offer any criticism; but, although the substance of the report is without doubt excellent, the form in which it is rendered appears to violate principles which are deemed to be, by some authorities, of great importance. The subject being one of considerable interest to R.E. officers, it appears permissible under the circumstances to call attention to these principles.

To start with reconnaissance in general, the first consideration is time. Were time available the G.O.C. would probably prefer to judge everything for himself on the spot. This being impossible he employs officers of his staff or of units to judge for him. The General Staff will be receiving many reports on divers subjects, and to save their time is a very important matter. This can surely best be done by *starting every report with a précis of the information obtained.* It can then be seen at a glance whether a certain route is practicable or not, which of several apparently convenient bridging sites is to be preferred, and so forth.

Provided that it is known that the judgment of the officer who has made the report is to be trusted, the *details* can be left for later consideration. When, after examining the *précis* of reports on alternative routes, etc., it is decided to make use of any particular one, the detailed information in that report must be distributed to those immediately concerned. To again save time, it is obviously desirable that *all information on any one subject should be grouped together under an appropriate heading, which should be clearly indicated by underlining or placing in the margin.* This sorting of information into headings will only mean a very slight extra trouble and loss of time to the officer carrying out the reconnaissance, but will result in a very great saving of time and trouble to everyone else who may have to extract the information from the report.

The second important consideration is for the officer carrying out the reconnaissance to be continually, in imagination, placing himself in the position of the officer who has ordered the reconnaissance and of those whom the details of the report will affect. It will then be easier to give the information acquired in the most useful form.

To come now to the particular case under consideration. Owing to the scheme being apparently part of a larger scheme known to the

Digitized by Google

officers on the tour, it does not give much information, and some of the following suggestions may thus, unavoidably, be not actually applicable: *e.g.* there may have been no heavy artillery on the right of the position, although this arm is mentioned in the printed report.

From the scheme as given, however, it would appear that the order for the reconnaissance was issued by the O.C. 55th (Field) Company, R.E., under the direction of the General Staff—the object of the latter being to discover if this road was practicable for artillery in retreat, and that of the former to ascertain how the road could be improved by one section of his company. The officers interested in the details will be the G.S., the O.C. R.A., the O.C. Field Company, R.E., and the O.C. Covering Force.

The *précis* might then take somewhat the following form :—

1. The road from Portinscale to Buttermere is impassable for heavy artillery, and only practicable at a slow rate for field and howitzer artillery, there being several very steep slopes where the ordinary teams would require assistance.

2. The road is screened from the enemy's view except for some 400 yards S.W. of Stair (A5).

3. To protect the retreat on this road a force, strength about ... (M.I. recommended if available) posted about Cat Bells (C6) should be sufficient.

4. The road could be materially improved by one section Field Company, R.E, in ... hours. Materials available locally.

The detailed information would then follow, grouped under such headings as watering places, halting places, side tracks or passing places, covering force (giving strength, position, and lines of retreat), width of road, surface, bridges, bad gradients involving assistance to the teams, giving exact site (so that if necessary operation orders may order increased distances between batteries, etc., to avoid blocks on the retreat), improvements proposed, giving order of importance; sites, details and time required. And so forth.

It certainly seems to me that a report in the above form will, to a General Staff working at high pressure, more nearly fulfil the requirements laid down in *F.S. Regs.*, Part I. (1909), para. 9, sub-para. 2, than would a "Road-Book" style of the report if handed in.

Yours faithfully,

B. BORRADAILE,
Capt., R.E.

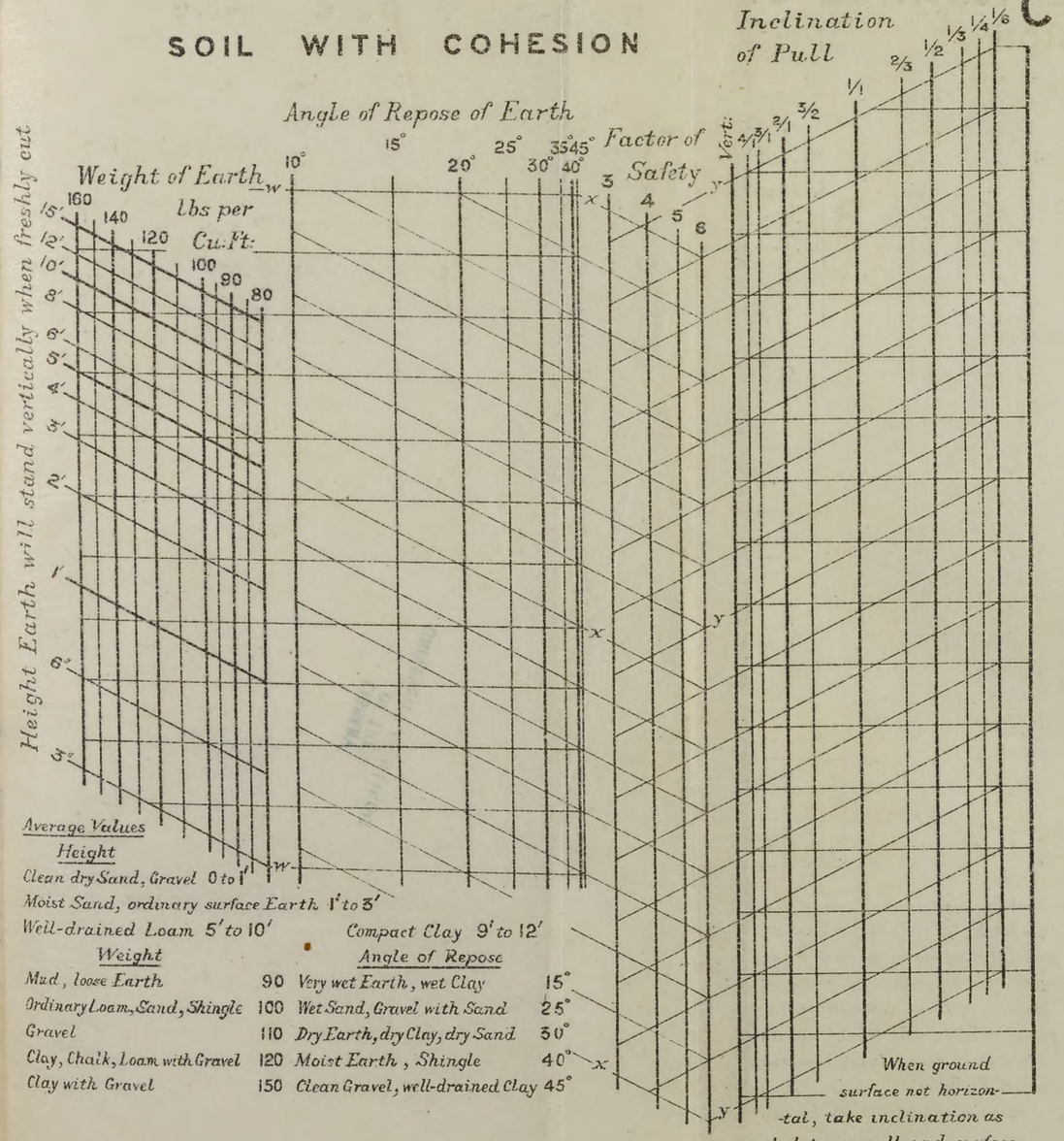
Tientsin, 27. 1. 12.

The Editor, *R.E. Journal.*

Digitized by Google

SAFE RESISTANCE OF BURIED ANCHORAGES

SOIL WITH COHESION

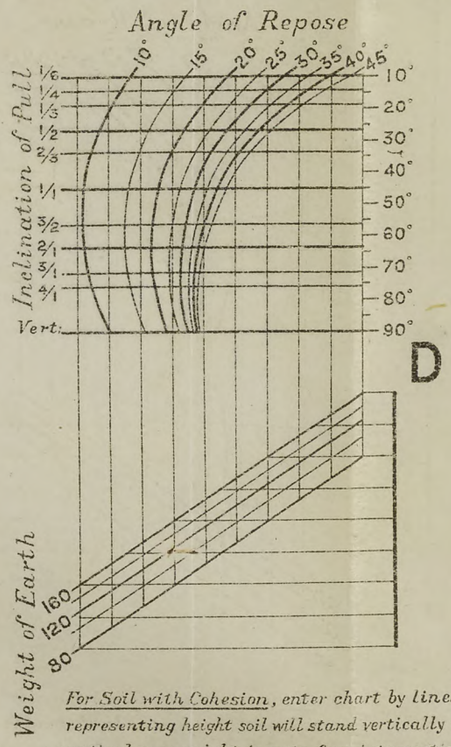

C
Inclination of Pull
Angle of Repose of Earth
Factor of Safety
Weight of Earth lbs per Cu. Ft.
Height Earth will stand vertically when freshly cut
Vert:
When ground surface not horizontal, take inclination as angle between pull and surface.

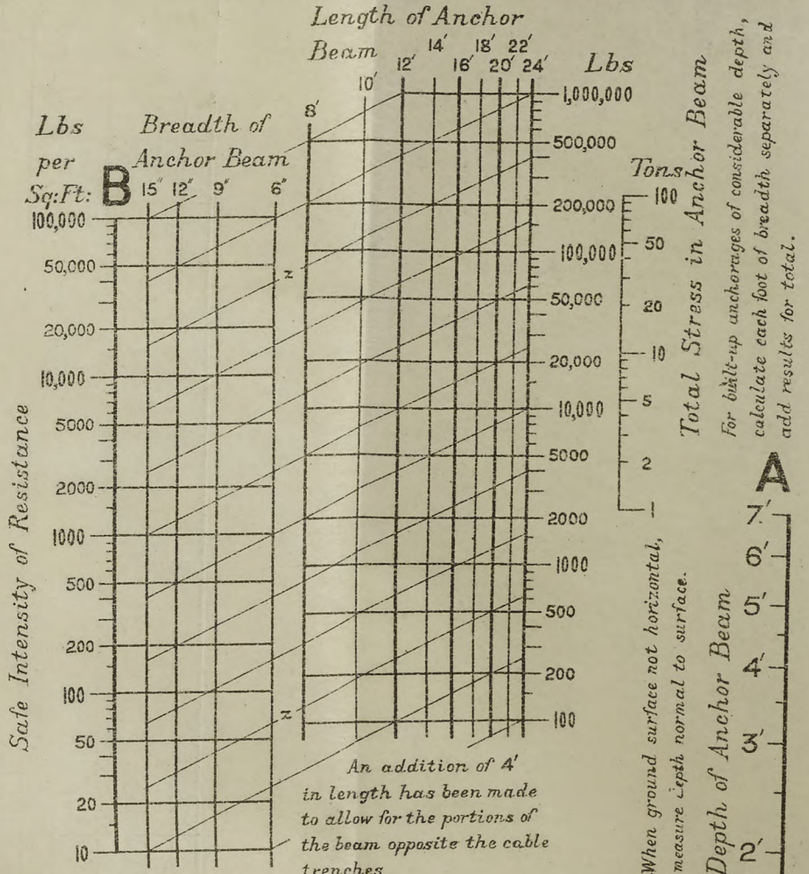
Average Values

Height	
Clean dry Sand, Gravel	0 to 1'
Moist Sand, ordinary surface Earth	1' to 3'
Well-drained Loam	5' to 10'
Compact Clay	9' to 12'

Weight		Angle of Repose	
Mud, loose Earth	90	Very wet Earth, wet Clay	15°
Ordinary Loam, Sand, Shingle	100	Wet Sand, Gravel with Sand	25°
Gravel	110	Dry Earth, dry Clay, dry Sand	30°
Clay, Chalk, Loam with Gravel	120	Moist Earth, Shingle	40°
Clay with Gravel	150	Clean Gravel, well-drained Clay	45°

SOIL WITHOUT COHESION



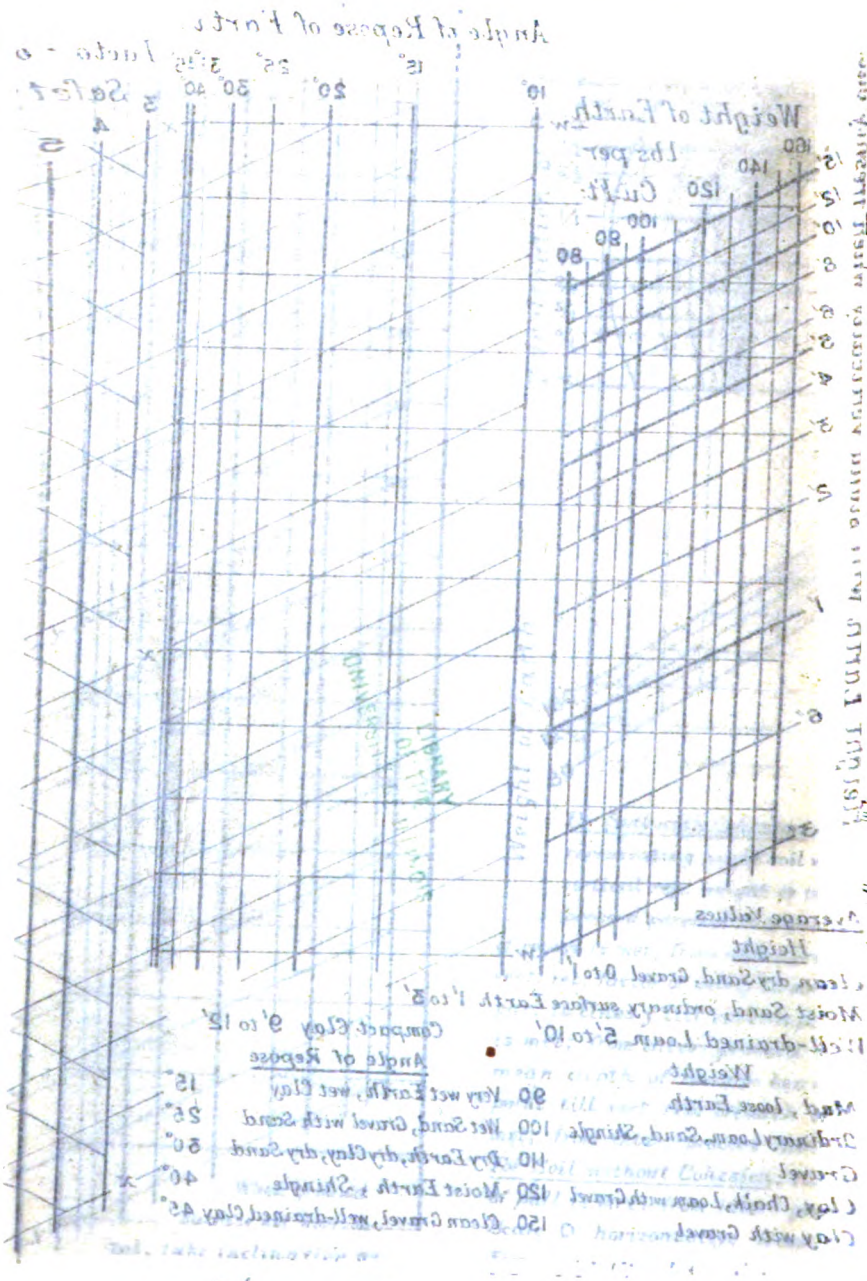

Length of Anchor Beam
Lbs
Breadth of Anchor Beam
B
Lbs per Sq: Ft:
Safe Intensity of Resistance
Tons
Total Stress in Anchor Beam
An addition of 4' in length has been made to allow for the portions of the beam opposite the cable trenches
When ground surface not horizontal, measure depth normal to surface.
A
Mean Depth of Anchor Beam

For Soil with Cohesion, enter chart by lines representing height soil will stand vertically till vertical rep: weight is met; from intersection proceed parallel to lines w till vert: rep: angle of repose is met; from inter: proceed par: to lines x till vert: rep: factor of safety is met; from inter: proceed par: to lines y till vert: rep: inclination of pull is met; from inter: proceed horizontally to Scale C. Join this point by a straight-edge to point on Scale A rep: mean depth of anchor beam; this will give safe intensity of resistance on Scale B. Proceed horizontally from this point till vert: rep: breadth of anchor beam is met; from inter: proceed par: to lines z till vert: rep: length of beam is met; from inter: proceed horizontally to scale rep: total safe stress in lbs or tons as required.

For Soil without Cohesion, such as shingle, enter by curved lines rep: angle of repose till horizontal rep: inclination of pull is met; from inter: proceed vertically till inclined lines rep: weight of soil is met; from inter: proceed to Scale D horizontally; from this point proceed as before.

For accuracy it is advisable to find the various intersections by ruling pencil lines on the chart.

Digitized by Google

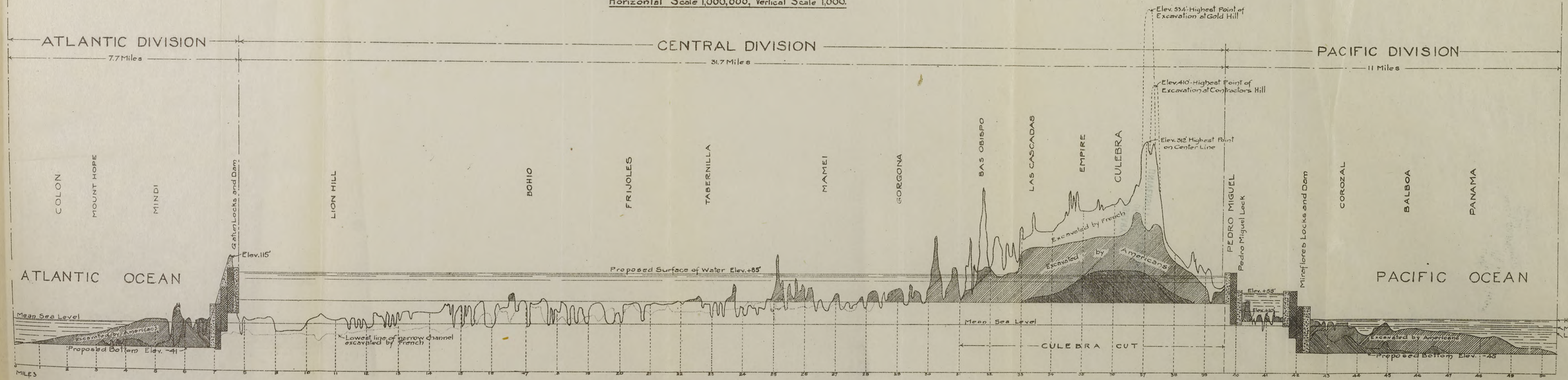


NOTES ON THE PANAMA CANAL.

PROFILE OF PANAMA CANAL.

Horizontal Scale 1,000,000, Vertical Scale 1,000.

FIG. 1.



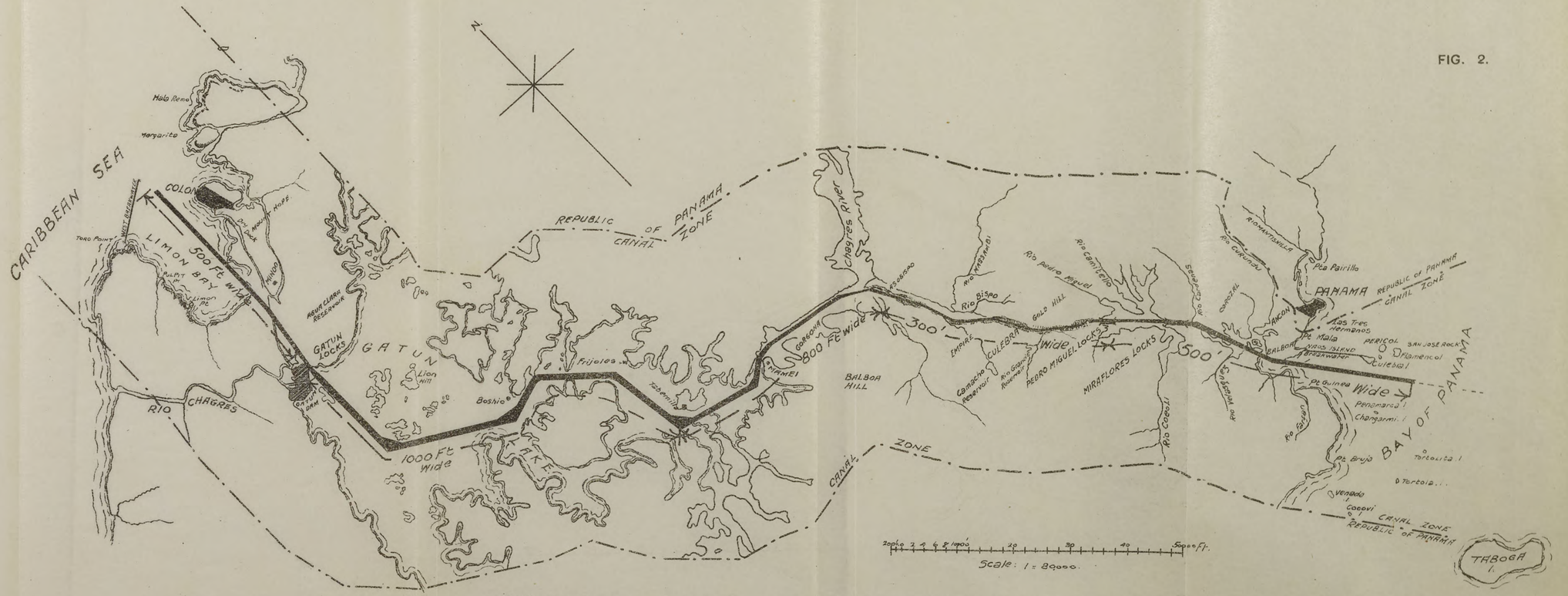
Taken out by Dredging | Taken out by Americans | Taken out by French

ALL DIVISIONS OF PANAMA CANAL

Digitized by Google

Digitized by Google

FIG. 2.



MAP SHOWING CHANNEL OF THE PANAMA CANAL.

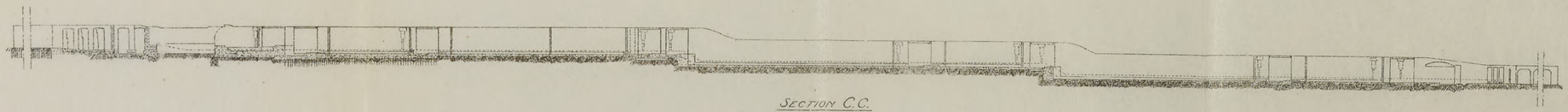
Digitized by Google

Digitized by Google

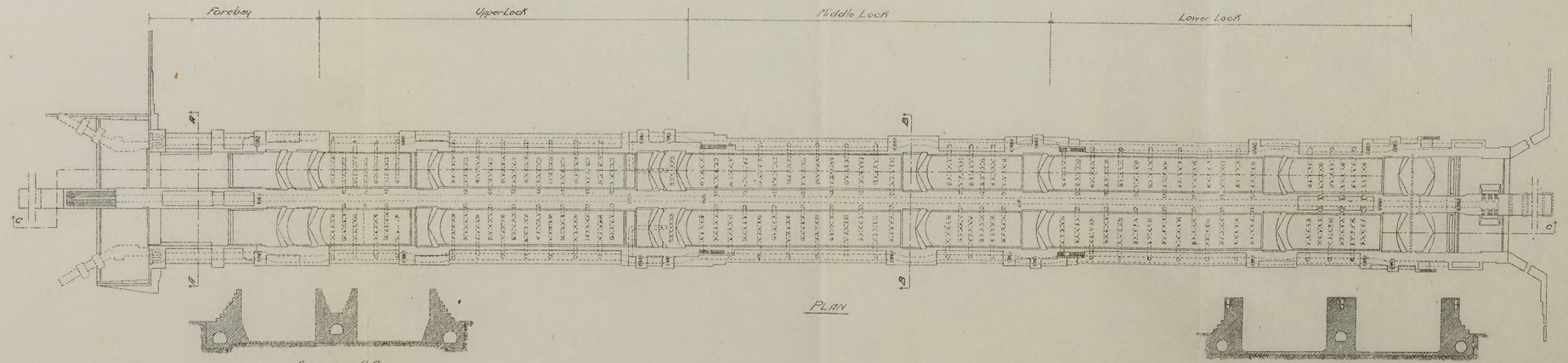
FIG. 3.

GATUN LOCKS.

Scale 1" = 200'



SECTION C.C.



PLAN

SECTION A.A.

SECTION B.B.

Digitized by Google

Digitized by Google

PETAWAWA CAMP, CANADA.

By LIEUT.-COLONEL G. S. MAUNSELL, R.C.E., *Director of Engineer Services, Canada.*

IN 1904 the Canadian Government purchased about 100 square miles of territory, 120 miles west of Ottawa, on a high plateau overlooking the Ottawa River, near the village of Petawawa. This is our Canadian Aldershot.

The following conditions influenced the selection of this site :— Good natural manœuvring area, facilities for artillery and rifle ranges, perfect water supply, proximity to the river for boating and bathing, and last, but not least, the natural beauty of the site.

In February, 1906, a committee was formed to decide, among other things, questions of policy which affected engineer services on this area. In the spring of that year work was commenced in laying out camp lines, roads, water supply, rifle and artillery ranges, telephones, and the construction of the most necessary buildings. The great difficulty at that time, in laying out the work, was to foresee to what extent the camp would eventually develop. As can easily be imagined, no definite figures were available as to future numbers of troops, but the estimates then made have so far worked out very satisfactorily.

It was decided to provide buildings for the following purposes :— Mess huts, and cookhouses for N.C.O.'s and men, hospital, offices, ordnance stores, stables, canteens, guard-house, and A.S.C. buildings.

A large number of these were erected in time for the first summer's training, the construction being of light wooden frames, with shingled roofs, and verandahs. These buildings have since been added to as necessity arose. All troops live under canvas and the general plan of the camp site (see *Plate*) shows the existing buildings.

Rifle Ranges.—A 600 yards rifle range has been provided, of 20 targets of the ordinary type. The construction is of crib and earth protection for the markers, earth firing points, and telephone communication. There is no stop butt, as the background is a dense wood.

An electrically manipulated target range, with annunciators on the firing points, which does away with the necessity of markers, was also constructed, but has not proved successful and is not much used. Field firing is arranged for annually, as laid down in Musketry Regulations, and has been carried out quite successfully—the ground being well suited for this purpose.

Digitized by Google

Artillery Ranges.—Natural artillery ranges exist upon this training area, both for heavy and field guns. These have been gradually improved each year by clearing additional firing points and opening up new ranges. Shelters and crow's nests have been built for observation of fire, and targets of all descriptions have been put up where required. This work, with the exception of clearing, has been done almost entirely by the gunners themselves, the sappers being busily engaged providing telephone communication with the observing stations, and other works.

Permanent telephone lines have been provided along all main lines, so that it is now only necessary to connect these by cable with new points each year, as ranges are changed or added to. A number of most effective "crow's nests" are being converted from steel triangulation survey towers, which have been turned into store.

Water Supply.—The water is obtained from two sources:—(*a*). Springs close to the shore of the Ottawa River. (*b*). Ottawa River. The former supply is used for drinking and ablution purposes, including shower baths, and the latter for fire protection, flushing closets and sewers. When there is a sufficient supply for all purposes, no river water is used, as an intake to the flushing system is installed to the spring reservoir as well as to the river.

These two supplies are independent systems, having independent intake pipes, boilers, engines, pumps, reservoirs, and pipe systems, with the exception that the latter has alternative sources of supply, river or springs. No river water is pumped through the drinking water system, as a matter of precaution only.

The drinking water system may be described briefly as follows:—Springs are found along the lower bank of the Ottawa River, from the mouth of the Petawawa River to west of the camp area. These have been improved so that from the 37 barrels, with porous tiles leading into them, a supply is now available of more than 200,000 gallons per diem.

From these barrels, pipes from 1″ to 3″ diameter are used to convey the water through various collecting barrels to the reservoir. The reservoir consists of five wooden tanks having a total capacity of 43,000 gallons. The overflow pipe reduces their total capacity to the above amount.

In the pump house two triplex 20-H.P. pumps, each run independently by a 20-H.P. high speed Leonard engine and boiler, are connected with the reservoir by separate 6″ cast-iron suction pipes. By valves the services of these two pumps can be utilized separately, or together, as necessitated by the consumption of water in the camps. A cross connection to the flushing and fire system is made just outside the pump house and regulated by a gate valve.

A steel tank of 50,000 gallons capacity, for storage and pressure in this system, has been put up on high ground, 145′ above the pumps.

Digitized by Google

The tower supporting this tank is 40′, and the tank 10′ high, giving an effective head, when full, of 45′ to the highest tap in the camp. The supply pipe from the pumps is 5″.

At the east end of the camp there are two wooden tanks on 16′ wooden trestle towers, having a total capacity of 16,000 gallons. Up to August, 1911, with two other tanks of equal capacity (situated near the 50,000-gallon steel tank but now removed) these constituted the reservoirs for this system, and they are still kept filled for emergency. It is intended to remove them to the spring water reservoir, and instal a new separate main to the East Camp from the steel tanks.

All distributing pipes in this system are galvanized iron, laid below frost action. All taps throughout the camp are installed on this system only.

The flushing and fire protection system is installed in the West Camp only, and is obtained from either the river or spring water reservoir. The intake is of 10″ cast-iron flanged pipes, and, outside the pump house, divides into two branches, one extending a distance of 420′ into the river, and the other to the spring water reservoir. Each of these is equipped with a 10″ gate valve. The depth of water over the screen of the intake is 2′ at low water.

The supply pipe is 8″ cast-iron spigot and faucet joint, connected to the two upstands of a 25,000-gallon tank on the same site as the drinking water pressure tank. By a valve on the supply pipe, direct, or tank pressure may be used. This tank is of steel, supported on a 40′ steel tower and concrete piers. Its construction is similar to the 50,000-gallon tank already described, having two 8″ upstands, supported on base elbows, constituting the main supply pipe. The tops of upstands are equipped with sleeve expansion joints. It has been found that this tank is taxed to its full capacity, owing to the number of sanitary fixtures to be flushed and that an additional tank must be provided shortly.

Sewerage System.—The camp area is divided into two portions—the East Camp for Militia units, and the West Camp for the Regular troops. The reason for this is that the Militia units usually train from 12 to 16 days, while the permanent troops occupy their camp for some months each year. It has therefore been found necessary to install a sewerage system in the West Camp, which disposes of all sewage and waste water, but not surface water.

All mains and branches are of 6″, 9″, 10″, and 12″ glazed sewer pipes, the size depending on the service and grades. The minimum grades used are:—6″ pipes, 1 in 80; 9″ pipes, 1 in 150; 10″ pipes, 1 in 170; 12″ pipes, 1 in 200.

At the east and west ends of the system, automatic flush tanks, 6″ outlet, give a sudden discharge of 600 gallons of water every 24 hours.

Digitized by Google

At the foot of the main outlet is located the sewage disposal works, which comprise the following:—Screening well, septic tank, filter beds, and outlet to river. The screening well consists of a concrete well at the end of the main sewer, fitted with four valves—one to each of the septic tanks already constructed, one to a by-pass to the river, and a fourth to provide a third septic tank if required. These are vertical hinged valves controlled by levers. The settling and liquefying tanks (two pairs) are of monolithic concrete construction. Each set can be used independently, and is provided with sludge valves, etc., complete. The total capacities of these are as follows:—

East tank.—Maximum capacity, 58,430 gallons.
Minimum capacity, 41,731 „
West tank.—Maximum capacity, 57,838 „
Minimum capacity, 41,139 „

In each case the settling tank has a capacity of about 20 per cent. of the total capacity. The sewage enters by a 12″ main from the screening well, having a vertical bell end, which is always submerged.

The aerating weir has a range of 30″ by which the time of detention in the tanks is controlled. From the weir the liquid is carried to the filter beds by aerating channels, having wells for each of the three beds with sluices which can be opened or closed as required. Three sets of vertical baffle boards are used in the liquefying tanks. The tanks are covered with ordinary 2″ planks, not fastened down. All sludge valves into the by-pass are manipulated by vertical spindle and wheel. The two liquefying tanks are connected with a 12″ valve for use when the tanks are used together.

The three filter beds have an average depth of 3·75′, length of 90′, and width of 26′, and are used intermittently. The effluent is distributed to the beds, as desired, by sluices. The beds consist of coarse river sand of 3′ 9″ deep, with under-drains of agricultural tiles. The central under-drain is 6″ diameter, and the converging branches 4″ drain placed in rows 6′ apart. All under-drains are covered with 9″ depth of crushed stone. The central main drain of each bed enters a main outlet, crossing the foot of each filter bed, and entering a manhole on the by-pass outlet. The effluent is distributed over the beds by 4″ × 6″ wooden troughs. These channels are controlled by the insertion of wooden blocks.

At the head of each branch under-drain are 4″ vertical aerating pipes brought to the surface and filled with broken stone.

The best sanitary fixtures are installed, *i.e.*:—W.C.'s, urinals, shower baths, wash basins, and kitchen sinks. All waste water is disposed of in this system, and no soak pits are used in the West Camp. Shower baths are considered a necessity in all camps of training.

Digitized by Google

Garbage is disposed of in incinerators, being removed from the kitchens by covered pails. No garbage is left uncovered, but destroyed immediately; the result being that the flies, which were most troublesome in former years, are now almost exterminated. Every kitchen is provided with an incinerator, built of brick, with cement joints, and coated with cement mortar. They are provided with iron grate bars set in concrete. It is found that they should be lined with fire brick, and contain cast-iron grates. The fuel used is wood in 4′ lengths placed under the grate.

Sanitary Arrangements, East Camp.—The waste water from the Militia Camp is carried by wooden troughs into soak pits. It has been found that in a camp of between 12 and 16 days, a pit of 4′ square and 5′ deep is practically full, and the power of absorption of the ground is exhausted. It has also been found that to use the pits to advantage they should not be sited in the same place more than two successive years. These pits are filled in after the termination of each camp.

As the water supply for these services is semi-permanent, thereby fixing their sites, only a limited amount of ground is available for them, it is therefore proposed to install a water-carrying sewer in this area to carry off waste water from the shower baths, ablution tables, and kitchen taps.

One clay incinerator per unit is constructed by the unit. One-inch water pipe, cut into lengths, is used as grate bars. A barrel is used for the form about which the clay is placed. These materials are provided from engineer stores.

Portable latrines of wooden construction are provided in this camp, care being taken to have all ventilating openings covered with fly screens. The pail system is used; these are removed daily, and emptied into the main sewer opening, provided for the purpose. This system has prevented the pollution of the ground, and with the installation of waste water sewers, connected to the sewage disposal works, the Militia Camp area from a sanitary point of view, should be as nearly as possible perfect.

The manure from all stables is carted daily to points at least one half-mile from the camp, and piled. In the autumn, what is required for fertilizing recreation grounds is drawn back to the camp, and spread where required. This also assists in eliminating the flies.

Buildings.—Several buildings may require special mention :—

A magazine and an explosive store have been built. The former of brick with mortar joints, the latter of concrete. Both with copper roof coverings, and asphalt floors.

The slaughter house was built a mile from the camp centre. It is a wooden frame building with a concrete floor, provided with slaughtering and chilling rooms. The chilling room is cooled by two ice houses, one on either side, with means of admitting the

Digitized by Google

cooled air, the latter are provided with air spaces in the walls, and ventilated. These stores remain completely closed during the summer months, otherwise the supply of ice would melt too rapidly. Separate ice stores are provided in the camp area, from which the several mess refrigerators are supplied daily. Being out of the range of the camp water supply, a special supply was installed for this service. The water is obtained from the Petawawa River, and pumped by a hot air Ericcson pump into a gravity tank which furnishes the necessary pressure.

The hospital buildings are not yet completed. Temporary buildngs have so far been used. An operating pavilion is ready for use, and the wards and other buildings are now being provided.

The operating pavilion is worthy of special description. It is of wooden frame construction with a concrete floor. The floor is rendered in cement, trowelled to a smooth finish, and is to be given two coats of "Trus-Con," a patented material for finishing with a glazed surface. In each room the concrete is extended to a height of 6" to form a base to the wall. The walls are to be plastered, over expanded metal, to a hard finish. All junctions of walls and ceilings, as well as those between floors and walls, are concave, so that no angular corners exist. The building is equipped throughout with the latest sanitary fixtures, and contains a preparing room, sterilizing room, ward, operating room, orderlies' room, kitchen, lavatories, and verandah. The hospital buildings will be connected to the sewage system.

A large recreation building has recently been completed for lectures, moving pictures, lantern slides, and general amusement for the men.

Transport Accommodation.—Transport arrangements and railway facilities have been well provided for. The main line of the Canadian Pacific Railway passes within 1½ miles of the actual camp site, and this company has laid a branch line to the camp station, with sidings for handling any number of trains. The Ordnance Stores and Army Service Corps buildings are at this point, and platform accommodation is being extended each year. Platforms are now under construction for loading and unloading horses. Portable ramps have so far been used. The Railway Company details a station agent for the training season, and the Government provide him with a station office and freight shed.

Camp Wharf.—A camp wharf was built in 1909, of hemlock cribs filled with stone. These cribs are 18′ × 9′, 40′ centre to centre, the intervening bays being supported on two pile bents about 10′ apart. The river being shallow at this point necessitated a connecting pier from the wharf to the shore, 600′ long. During the first season a trestle bridge was built for the connecting link by a Militia field company, for training, and it was dismantled in the autumn. The

Digitized by Google

following winter a substantial bridge was built on heavy red pine piles, driven 6′ in the ground, and strongly cross-braced. The river at that point is 2 miles wide, the main current being near the opposite shore. From all appearances the ice in the spring would have little effect on a pier there, but it was found the following spring that the ice had pushed over several piles and damaged the bridge. The experience of a second winter showed a similar effect and slight damage, and the conclusion now come to is that nothing short of a continuous stone-filled pier will stand the ice pressure. Apparently the expansion of the ice in the spring bears against the opposite shore, which is steep and holds its ground, whilst on the camp site the ice slides up the gradual slope of the shore.

Camp Roads.—The natural surface of the ground being sandy, the traffic through the camp created such a dust that metalling of all main camp roads was imperative. A stone-crushing plant having been secured, and a granite quarry found near the camp site, material was at hand, the chief difficulty being that it had to be drawn up French's Hill, 160′ in height. This added considerably to the cost. (This hill was named after Capt. P. H. French, R.E., who was loaned to the Canadian Government, and was Camp Engineer during construction). The soil being very sandy, the following foundation was laid on the hill, with good results :—Long stringers of timber 4″ to 5″ diameter were bedded horizontally in the sand in three rows, across these were spiked mill slabs, and the top covered with sand. Hundreds of tons of stone and materials, including all stone for concrete and roads, have been drawn up this hill, with very little improvement except the renewal of the covering.

The following is the method of construction of camp roads :—The bottom consists of large stones, well packed, and blinded with sand. On this is laid 7″ of crushed stone covered with crusher dust, clay, or ballast, and rolled to a finished road bed with a steam roller. Only certain roads are finished to date and these must be extended gradually as time and funds permit. The cost of these roads averages about $6,864 per mile. Rustic fences have been put up along these roadways to mark and keep the traffic entirely upon them.

Telephone and Telegraph Services.—All offices, Officers' and Sergeants' Messes, stores, depôts, and artillery ranges, are connected with a telephone system, as well as Petawawa Railway Station, Post Office, and Pembroke. The exchange has accommodation for 100 lines. All lines in the camp are of permanent construction, and also distributing points for artillery splinter-proofs, and observation posts, from which points insulated cable is laid annually during artillery practice. Long-distance equipment and metallic circuit is used throughout. The portable telephones for artillery firing points are also now being equipped with long-distance equipment. The

Digitized by Google

exchange is connected with the Bell Telephone Company Exchange at Pembroke (12 miles), with one trunk line, and from any office long-distance connection can be made with Ottawa, Montreal, Quebec, Kingston, Toronto, or any other place within the limit of the Bell Telephone Company's equipment.

Telegraph offices are opened in the camp during the training seasons by the C.P.R. and G.N.W. Companies, offices being provided for them.

All telephone lines were built by the sappers and the Exchange operators are supplied by the R.C.E.

Lighting Plant.—An acetylene gas plant is installed to light all buildings and grounds. This system now covers a large area, and is found very satisfactory. A number of portable acetylene gas lamps are kept for use where specially required. These portable lamps are made to hold either 1 lb. of carbide, to burn about 5 hours, or 2 lbs. to burn about 10 hours.

Nearly all engineer services, since the first and second year, have been carried out by day labour. The material is purchased well in advance, and with the supervision which the Camp Engineer and Foreman of Works are able to give to the works, very beneficial results are obtained, both financially and otherwise.

No troops remain in Petawawa Camp during the winter season. One caretaker, and one engineer storekeeper being the only occupants of the actual camp. Besides these, several rangers are posted at intervals over the property.

The Petawawa Fish and Game Club has been organized amongst the officers of the Canadian forces (and it is interesting to state that a few Imperial officers still remain on the list of members). Several club houses have been built, and game is well preserved. The game includes moose, deer, partridge and woodcock; salmon, trout and bass are found in the lakes and rivers. The grounds are bounded by rivers on three sides and contain numerous lakes.

The training as a rule consists of (*a*) one or more Militia camps of from 12 to 16 days, in June, of all arms, including all Militia units of engineers. (*b*). All Militia artillery training, and gun practice from June to August under permanent corps instruction. (*c*). Camp of training in August for all arms of the Regular forces.

The Camp Engineer has a detachment of R.C.E. during the constructional period from May to October to assist and supervise civil labour in carrying out Engineer Services.

Digitized by Google

LIEUT.-COLONEL SIR RICHARD FLETCHER, BART., K.C.B., R.E.

By COLONEL E. A. MACARTNEY-FILGATE.

COLONEL SIR RICHARD FLETCHER, R.E., to whose skill the famous lines of Torres Vedras owed their strength, fell on August 31st, 1813, during the second siege of San Sebastian. He was discussing with Sir Thomas Graham the situation created by the repulse of the earlier attacks upon the breach in the curtain of the fortress, and was apparently about to cross the Urumea River at a spot known to-day as the Arenal de Gros when he was killed.

His body with those of several other English officers was buried on the height of Aitzerrota (Molino de Mento) on what is now called "La Cumbre," the estate of the Duke of Tovar.

A simple monument was then erected, and the description thereof is in possession of the curator of the Municipal Museum at San Sebastian, Don Pedro de Soraluce. During the first Carlist War in 1836 the monument was respected both by the Carlists and Christinos, but somewhere about 50 years ago it disappeared; very probably when a good deal of remodelling of the town and suburbs took place. About this time right out on the bluff headland of La Mota overlooking the Bay of Biscay some crude memorial tablets were placed in position to the memory principally of British officers of the British Legion who were fighting for the Christino cause in 1836, and one was also placed there to the memory of Sir Richard Fletcher. It has nothing to do with his grave or with the original memorial and is thought to have been placed there as a compensation for the destruction of the grave and monument.

The place where he fell, Arenal del Gros, is on the eastern side of the Urumea at the foot of the Chofre Sandhills where the principal breaching batteries were in position, the place where he was buried is west of the Urumea on the heights of San Bartolomeo.

San Sebastian is a favourite study of the Spanish historian and especially of the Spanish Army, their engineers frequently visiting it as students of the art of siege. The story of Graham's two sieges is as well known to them as that of the Battle of Hastings to an English schoolboy, and the death of Fletcher is to them something to be spoken of with the deepest reverence. "Was he not a great soldier?" they ask. "Was he not the greatest field engineer of his

Digitized by Google

age ?" Ask any Spanish engineer officer his opinion of Fletcher and you will get an answer that will show you how deeply his memory is respected as a great master of his art. "No soldier," said one to me, "ever showed the world so clearly that the power of the spade in war is inestimable." And soldier and civilian alike make no secret of the fact that they are amazed that no monolith or pillar stands in some prominent position in or above the town to perpetuate the memory of the master architect of the famous lines covering Lisbon. Every one who talks of the siege rubs the point in, most of the military critics claiming that "Fletcher broke Napoleon because he constructed the lines which first stopped the flood tide of victory," or words to that effect. They also freely remind you that, in his defence of Bayonne with its Bidassoa and Nivelle Lines outer, and Nive (inner) Soult copied Fletcher's work.

Nor do they confine themselves to conversation. The Press returns again and again to the point. Within the last year or so *El Pueblo Vasa*, the Guipuscoan newspaper, has at different times, when describing visits of officers, made the following references :—

"We made a minute topographical investigation in order to bring to light the particulars of the interment of the famous English Colonel of Engineers, Sir Richard Fletcher, the famous author of the celebrated lines of Torres Vedras in Portugal, where the power of Napoleon I. was broken thus beginning the fall of his glory."

Again : "It is incomprehensible the conduct of the English Government towards Sir Richard Fletcher, as at the time they ordered a mausoleum to be built on his anniversary in Westminster Abbey, yet they never thought of his mortal remains."

Again: "What different treatment the famous author of the lines of Torres Vedras deserves."

Again: "Some days ago a group of students of the Academy of Military Engineers of Guadalagara met in Guipuscoa for a trip of practice. They examined the French plans of the Siege of San Sebastian during their visit to that city. They had a learned discussion about it and especially on the famous English Colonel of Engineers, Sir Richard Fletcher, the author of the celebrated lines of Torres Vedras."

I have given very literal translations. They convey the Spanish point of view, better than a more literary translation.

The extracts and opinions quoted show the remarkable veneration in which Fletcher's memory is held in Spain, and as 1913 approaches that veneration, by the historical association of the centenary of the siege, is being thrown into strong relief. *Pari passu* with that feeling is a disappointment, almost in fact a resentment, that England is apparently too negligent of the memories of her great men to realize that Fletcher was the greatest exponent of the art of the spade in the field, and of its power to influence the strategy of any campaign great or small in a remarkable degree.

Digitized by Google

CENTENARY REMINISCENCES OF SIR CHARLES PASLEY.

By COLONEL B. R. WARD, R.E.

CHARLES PASLEY was born at Eskdalemuir, Dumfriesshire, on the 8th September, 1780. On the 1st December, 1797, he was gazetted 2nd Lieutenant in the Royal Artillery, and joined at Woolwich in order to learn his duties before joining his company at Brentwood in Essex. His name had however been put down on the list for the Engineers, and he was transferred on the 1st April, 1798, to that Corps. His first station was Portsmouth, where he remained nearly a year, and was employed on the construction of a new gun-wharf. On the 3rd March, 1799, he sailed from Portsmouth, having been appointed to the Island of Minorca. Here he remained for the next two and a-half years, employed on the construction of Martello Towers and other fortification works. Sir Ralph Abercromby touched at Minorca on his way out to Egypt in the summer of 1800, and would have taken Pasley with him, but he could not be spared from his work.

On the 13th December, 1800, Sir Ralph wrote from Malta to General Dirom, a connection of Pasley's by marriage: "Last summer *I met* at Minorca a relation of Mrs. Dirom's, Mr. Pasley, a young Engineer. There appeared so much of character in him that on enquiry of Capt. D'Arcy, the Chief Engineer, I found that he was a young man of the greatest diligence and zeal in his profession, and that he promised to do much credit to it and to himself. He wished to go with me, but Capt. D'Arcy could not spare him. It is fair that his relations should know his merit."

On the 9th June, 1801—three months after the death of Sir Ralph Abercromby at Alexandria—Pasley wrote to an uncle at home: "My hopes of seeing service this war seem to be at an end. I have therefore made myself perfectly contented, and shall aim only to endeavour to qualify myself for action should it occur."

The news of the Peace of Amiens in the autumn of 1801 came as a great blow to the little garrison of Minorca. "French Cartels," wrote Pasley, "bring intelligence of peace, that everything is to be given up on both sides, we only retaining Ceylon and Trinidad,

Digitized by Google

Malta to return to the Knights of St. John, and to be protected by a third Power. The Cape of Good Hope to be opened to France and Britain, Egypt to return to the Turk, etc.

* * * * *

Men's minds confined to one spot become narrow, we curse the Treaty, abuse Ministers, and ask what more they could have done had we been beat by land and sea. But the cession of Minorca above all annoys us; and at the expectation of leaving a spot so long familiar to us, we discover the attachment which we would not before confess."

The short truce that followed the Peace of Amiens was the only respite in the long struggle between England and France that lasted from 1793 to 1815.

Nelson had expressed in bitter terms his indignation at the manner in which the London mob had welcomed the French General who brought the ratification saying "that they made him ashamed of his country."

Pasley was soon afterwards ordered to Malta, where he landed on the 22nd November, 1801.

The next year was spent on duty at Malta, and included an interesting trip to Egypt on leave.

Like many other young and ardent officers of the time he chafed however at the national inaction, and longed for vigorous measures to be adopted against the overweening ambition of Napoleon. At last in May, 1803, war was again declared, and Pasley writes to a correspondent at home: "I had yesterday the pleasure of receiving your letter by the *Amphion* frigate which brought out Lord Nelson and the welcome news of war. I have not yet been able to see the celebrated character, who was received on his landing by the loyal acclamations of the Maltese, being no less a favourite with the multitude here than in England. He took seven prizes by the way, and sails in a few days to assume the command of our fleet before Toulon."

A month later Pasley wrote: "I began to fear, as one indignity succeeded to another that we should soon have reason to be ashamed of our country. And I will declare that the day I beheld Lord Nelson's flag entering this harbour, and heard the welcome news of war was the happiest of my life, as that when the articles of the last peace were shown to me was, without exception, one of the gloomiest."

From May, 1803, to August, 1805, during and after the Toulon blockade, Nelson left the *Victory* but three times. On each occasion he left the ship on duty, and his absence never exceeded an hour.

He himself spoke of the patience with which he had watched Toulon as a perseverance at sea which had never been surpassed.

It was during the period of this blockade that Pasley was sent on a confidential mission to the great Admiral. It had been resolved to

Digitized by Google

send an Engineer to the fleet in order to report on certain engineering questions in connection with the proposed fortifying of the Magdalene Islands, and Pasley was selected for the mission. The following extracts from his letters describe his impressions of the Navy and his meeting with Nelson :—

22*nd Feby.*, 1804, *Malta*.—"I arrived Wednesday at this Island after an absence of four weeks, having gone to take a cruise in the *Kent* with Admiral Sir Richard Bickerton who was proceeding to join the Fleet.

o o o o o

I had the honour of being introduced to Lord Nelson and of dining in company with that illustrious character, whom I had so long wished to see. He is now extremely sanguine in his expectations that the French Fleet, which is ready for sea, will come out. The general supposition is that they will make a run for Egypt with troops. They must do something soon, and I make no doubt we yet shall hear or see great things. His Lordship's ardent mind is so much bent on the destruction of the enemy that he thinks and talks of nothing else."

In another letter he writes :

"At four o'clock I went on board the *Victory* to dine with Lord Nelson, to whom I was introduced by Sir R. Bickerton, who had the goodness to give me a passage out in his ship. I had long had a great desire to behold this illustrious character whose heroic deeds have filled the world with astonishment, and will form the admiration of posterity. His appearance, a thin middle-aged figure, would be by no means striking if the want of an arm and a shade over one eye did not suggest to you the memory of the high services he has rendered his country. Who would not be content to lose a few spare limbs, and life itself, to have rendered such services ! Our conversation was short and commonplace, and I did not sit near him at dinner, but I remarked the keenness of his look and gesture which announced the decision of his soul."

During his visit Pasley was much struck by "the zeal of the captains of the Fleet, and how interested they seem in everything concerning their ships and men, which appear entirely to engross their minds."

Not many landsmen were privileged to mix with Nelson's famous "Band of Brothers"—the captains of the Toulon blockading fleet—and the lesson was not thrown away upon Pasley.

The group of young R.E. officers who backed up and encouraged Pasley in all his schemes of reform and made his work effective both as regards the reorganization of the Corps of Royal Engineers and the change in our military policy generally, were no less a band of brothers than were the captains of Nelson's fleet.

Looking back over the history of the Corps during the last hundred years, it is clear that its development and growth has been one of the most remarkable phenomena in British military history.

Digitized by Google

Many causes have contributed towards this development, the most important perhaps being first the advance of science in all directions and secondly the expansion of the British Empire. The application of science to the art of war has brought about the existing highly specialized condition of the Corps; and the expansion of the Empire during the mid-Victorian period favoured the employment of military engineers in the early development of colonies in Canada, Africa and Australasia. In our Indian Empire the development of railway communication and great irrigation works have given scope for the activities of many officers of Royal Engineers.

To put it shortly, the nineteenth century has been a century of opportunity for the Corps. That the Corps seized its opportunity and made the most of it is generally recognized.

The debt that the Corps owes to those men who fashioned it into an instrument fit for Imperial use both in peace and war is not perhaps so clearly recognized.

The object of this paper is to show how prominent was the part played by Sir Charles Pasley, and the group of R.E. officers who gathered round him, not only in the work of reorganizing the Corps of Royal Engineers but also in inspiring a vigorous military policy during the last 10 years of the great struggle with Napoleon.

It was on the 4th May, 1812—just a hundred years ago—that Capt. Pasley was ordered to proceed to Chatham to take charge of a party of junior officers, and a strong detachment of non-commissioned officers and privates of the Royal Military Artificers in order to instruct them "in the duties of sapping and mining, and other military fieldworks."

Capt. Pasley was appointed Director of the new establishment with the rank of major; and the centenary celebrations to be held at the School of Military Engineering this summer sufficiently indicate the importance attached by the Corps generally to the work then initiated by Pasley.

If we assume as an axiom that society is an extension of the individual, the Corps of Royal Engineers as it exists at the present moment may be looked upon as an extension of the personality of Charles Pasley more than of any other single individual.

The credit for the great work of reorganization effected during the early decades of the nineteenth century should not however be given entirely to Pasley.

The regeneration of Italy in the nineteenth century was effected by a group. Mazzini inspired the movement, Garibaldi was its soldier, and Cavour the statesman of United Italy.

When Pasley joined at Chatham as Director of the R.E. Establishment in May, 1812, the group of which he was at the time the most distinguished representative had already done the most important part of its work. That work was nothing less than to inspire a new

Digitized by Google

Imperial policy, and to pave the way for the reform of our existing military institutions.

It is impossible for us at the present day to realize the indignation felt by ardent young officers of the land service at the ineffective conduct of British military operations on land from 1793 to 1810, without access to the private correspondence of officers employed in those operations.

With the exception of Sir Ralph Abercromby's success in Egypt in 1801, Sir John Stuart's victory at Maida in 1806, and the expedition to Copenhagen in 1807, the history of the military operations of the time is nothing but a melancholy succession of desultory expeditions ending, without effecting any useful object, in retreat and re-embarkation.

Pasley had been with Sir John Stuart at Maida in Calabria and had seen the bayonet charge of the Light Infantry Brigade under Colonel Kemp. He was therefore firmly convinced of the extraordinary valour of British soldiers.

He had also accompanied Lord Cathcart to Copenhagen and had been powerfully impressed by the personality of Sir Arthur Wellesley, whom he recognized as the one man to be safely entrusted with a large British force.

The following contemporary letters allude to these two events.

Pasley is describing the moment at the Battle of Maida when Colonel Kemp was leading on the Light Infantry Brigade to charge the enemy. He writes :

"The French line, on the other hand was advancing with the same intention and in perfect order. The suspense was awful till the lines arrived within a short distance of each other, when Colonel Kemp, addressing his men with these impressive words: 'Now is the time to show you are British soldiers!' gave the order to charge; and the Light Infantry with a dreadful shout, after pouring in a destructive fire, rushed upon the enemy. The French awaited the onset with the utmost firmness till the points of the bayonets almost crossed each other; they then turned their backs to a man, as if by word of command, and in a moment the field of action, the bed of the river, and the woody heights beyond it, where Colonel Kemp pursued them without allowing them a moment to rally, were covered with their dead and wounded."

Soon after his return from Copenhagen he writes :

"Upon the whole the impression I derived from the Copenhagen expedition has not been of a satisfactory nature. In Calabria I learned that the British troops had no equals in valour, but in Denmark, where they had no opportunity of displaying that quality, I saw that the best soldiers in the world are of no avail unless properly managed. I must acknowledge that one masterly thing was done, when Sir Arthur Wellesley, with very inferior numbers, entirely routed the Danish Militia,

Digitized by Google

8,000 strong, taking one-fourth of them prisoners, and *he is* the man whom I would wish to see at the head of the first large British army that acts."

In April, 1809, after his return from Sir John Moore's Spanish expedition, Pasley wrote to his friend Capt. Burgoyne describing the Battle of Corunna: "On the 16th the enemy under Marshal Soult, made a general attack upon our army in a position about 2 miles from the city, taken to cover the preparations for embarkation. The left of our position was not bad, but our right flank was placed at the *bottom* of a hill on the summit of which the enemy were posted. Most of our artillery and stores had been embarked and were of little use in the action. The enemy's cannon commanded our whole line, and the right of it especially, which was within grapeshot. They had a birds-eye view of everything we did. Under such advantages they certainly must have expected a certain and easy victory, when they made their attack about two in the afternoon. Sir David Baird, whose division was on our right, was wounded by a grapeshot soon after the action began, and was obliged to quit the field. Our Commander-in-Chief, Sir John Moore, was also wounded by a cannon shot about the same time, and carried to Corunna, where he died the same evening. The 42nd Regiment began the action; that regiment and the 50th were the most hotly engaged, and suffered most. The latter had its two majors, one of whom commanded, both killed; but no disadvantages of position, loss of generals or officers of rank could dispirit the British soldiers."

Pasley's experiences on active service had shown him two things. One was that we had a man capable of leading a large British army, and the other was that the rank and file of our army was unequalled.

Under these circumstances he saw how unreasonable was the national despondency, and he determined in his own words written years afterwards "to combat the desponding opinions which then prevailed of the superiority of the French armies, generals, etc., and of the irresistible, or, as it was termed, the *dreadful* power of Napoleon."

In the letter written in April, 1809, to Capt. Burgoyne already quoted, Pasley urges him to "think on invasions and study campaigns" which, he adds, "I intend to do, but I find that I shall have about 10 towers to build on the coast between the mouth of the Colne and Hornsey Island, to do justice to which service will require all the personal activity I possess, and leave me scarcely time to think."

Pasley himself, and not Burgoyne, was however destined to be the spokesman of the group, and to rouse the nation as well as the Corps to a realization of the necessity of waking up to a sense of their military shortcomings. The two young officers—two of the most

Digitized by Google

famous names in the long roll of the Corps—had for some years been discussing the question of writing something of an historical nature, which should bring home to the minds of our people the necessity for a more vigorous policy.

For instance on the 25th December, 1806, Burgoyne had written to Pasley from Messina : "I wish very much you would (as you seem to hint you have an inclination) make out an account of the historical facts ancient and modern, with remarks and reflections, to prove to our doubting countrymen the eminent superiority of British courage and discipline, and even *generalship*, *enterprise*, and *skill* in the art of war, wherever they have a fair trial, to our boasting enemy.

"The only instances which can be attempted to be brought to the contrary (such as the continental expeditions of our last war) are invariably owing to the bad arrangements of the Ministers, and to their sending an inadequate force for the object designed. Something very interesting and new, and (by detailing the examples) improving work might be written on this subject.

"The wars in India would furnish admirable examples, and further back Marlborough's, Stairs' and Peterborough's campaigns, etc., etc."

On his return from the Corunna expedition, Pasley set to work to put his ideas to paper, and soon became very much engrossed in his work. Active service in the field interfered however with his project at the time, and on the 3rd July, 1809, he writes that he is on the point of departure for the coast "to join the expedition now preparing." This expedition was none other than the ill-fated Walcheren expedition, and it will be seen from the following extract that Pasley must have had serious misgivings as to the success of the enterprise.

"You will see from the papers," he writes, "that Lord Chatham is to command us on this expedition. I always hope the best on any new enterprise, and therefore hope he may inherit something of his father's spirit, and not prove one of those retreating and re-imbarking Generals, who have succeeded to the Marlboroughs and Peterboroughs of former times. I was at first so vexed at not being able to finish my book that it almost made me ill, but my former military ardour has now returned since I saw the thing was impossible. . . . I shall probably embark at Portsmouth, which will be very pleasant on account of so many friends being there. I am very angry with Lord Cochrane, who has been the cause of so much trouble, and prevents your brother taking out Lord Wellesley."

The event fully realized Pasley's gloomiest anticipations. The failure of the Army and the Navy to co-operate has been commemorated in the well-known epigram :—

"The Earl of Chatham with sword drawn
Stood waiting for Sir Richard Strachan ;
Sir Richard wanted to be at 'em,
But waited for the Earl of Chatham."

Digitized by Google

Pasley landed in Holland on the 8th August after the siege had been five or six days in progress, and the following extract from a letter to Capt. Squire, R.E., an enthusiastic member of Pasley's group who was serving in the expedition under Sir John Hope, gives some idea of how little had been done before his arrival. Now that a hundred years have gone by we may however study it with advantage, as it gives us a glimpse of the abyss of inefficiency and dishonour from which Pasley and his group rescued the Corps of Royal Engineers :—

"*Walcheren, 9th August*, 1809.—I this day landed your horse and sent him by your servant. I only landed yesterday morning, and saw our works before Flushing. In *six* days, since the trenches were opened, we have only made one 6-gun and one 6-mortar battery, with a parcel of infernal ins and outs from 800 to 1,000 yards from the place. . . ."

Four days later Pasley was sent for by Sir Eyre Coote and was placed in charge of the works on the left. He was informed that he would not be interfered with, and received orders to push on to the sea dyke as quickly and as close to the town as possible. That same night he proposed to push forward about ¾ mile in front of a battery of 24 pounders which had been constructed at such a distance that it could not reach the place nor injure the enemy in any way. From this point he proposed to storm a French 2-gun battery.

This scheme was approved, but the execution was put off until the next night, the 14th.

The following is Pasley's account of the affair, which resulted in the surrender of Flushing :—

"Colonel Pack of the 71st was appointed to command the party for the attack, whom I of course was to accompany in order to put the ground we gained in a state of defence, if tenable, or if not tenable to give, as Engineer, an official opinion. We took the battery in a moment, driving in their sentries and pickets like sheep, some of whom I believe were drowned running into deep water in their fright. There was a very strong party in the battery, part of whom ran away after little resistance, the rest about 40, were taken prisoners and sent off. In the attack on the battery, I was wounded by a bayonet which passed through my thigh, but gave me little pain, and did not prevent my walking. By the light of the shells, and the fires in Flushing, I saw that this battery was completely covered by the town. I therefore reported it untenable to Colonel Pack. In the meantime a large party of French formed in line, just under the battery where we were, and kept up a heavy fire upon us. At that time all our men were all dispersed by twos and threes owing to the darkness and confusion, and I do not believe there was one-third of the numbers of the enemy. Colonel Pack was collecting his soldiers to charge them. At this time I was shot through the body and completely knocked over. When I recovered myself a

Digitized by Google

little, I thought it best to go off before I got stiff. After I was nearly exhausted I met some soldiers coming to carry off our wounded who took me to a hospital.

"When I got there I could not move a single limb, nor even turn my head without assistance. The surgeons say that both were narrow escapes. The bayonet wound passed near a great artery, and the other grazed my backbone. That night an officer in the same business was shot dead. One who was brought to the hospital after me died in two hours. Another is still lingering who was badly wounded. The occasion of our great loss was employing too few men in the enterprise. If Colonel Pack had had 50 or 100 more with him, we might have taken the whole of the second as well as the first party of French with little loss. As it was he contrived to disperse them before he retreated from the scene of action. Flushing surrendered the next morning."

The attack on Flushing had succeeded, but the success was due more to the desperate assault and to an incendiary bombardment, than to any skill or science on the part of the Engineers with the besieging force. The success was however not followed up, the services of our splendid force of nearly 40,000 men being uselessly wasted by the inactivity of their commander.

No attempt was made on Antwerp, the chief object of the expedition; and Flushing was evacuated after the force had been decimated, and many of the survivors injured for life by the pestilential climate of Walcheren.

Pasley was sent home on a year's sick leave, and at last found himself with sufficient leisure to think out the plan of his proposed work.

Keenly as he felt the inefficiency of his Corps, and their failure to come up to the expectations of the Army in executing their technical duties at sieges, he realized still more keenly that the national policy was at fault.

"As our naval superiority," he writes, "now opposed an impenetrable barrier to all attempts at invasion, which nothing but peace with Napoleon could break down, I became convinced that the best defence of our own country, under these circumstances, would be to attack the enemy." Disheartening as all previous military failures, including the disastrous Walcheren expedition, had been, "yet," he continues, "considering, on mature reflection, that it was not too late to adopt a more vigorous system of warfare, I endeavoured, in the first part of my *Essay on the Military Policy and Institutions of the British Empire*, published in November, 1810, to combat the desponding opinions which then prevailed of the superiority of the French armies, generals, etc., and of the irresistible, or, as it was termed, *dreadful* power of Napoleon, recommending the abandonment of those desultory expeditions, which, with the exception of that to Copenhagen, had ended, without effecting any useful object,

Digitized by Google

in retreat, re-embarkation, and disgrace; and the adoption of a more vigorous system of warfare, with a view to the destruction of the great empire formed by that extraordinary man, for which I recommended the employment of our whole disposable army in Spain, no longer as auxiliaries of the Spaniards, but as principals in the war. These opinions are admitted to have produced more effect on the public mind than any of the numerous publications on the defence of the country, or on the management of the war, that appeared in those days of national danger and difficulty, and therefore my essay contributed, so far as such a work could possibly do, that is in a comparatively humble degree, to the success of the war."

The foregoing sentences were written by Pasley some 35 years after the first publication of the Essay, and are interesting as showing his own estimate of the value of his work.

The Duke of Wellington once said of Burgoyne: "If he only knew his own value, no one would equal him."

Pasley was no more pushing and self-seeking than his *lifelong* friend, Sir John Burgoyne; but we can supplement and confirm Pasley's modest estimate of the impression produced by his Essay by contemporary criticism.

We all know how Gillray's caricatures of the "Corsican Ogre" helped to keep up the spirits of our countrymen during the most depressing periods of the great Napoleonic struggle. Pasley's *Essay on the Military Policy of the British Empire* was first published in November, 1810. A second edition appeared in March and a third in October, 1811. The fourth and last edition was published in November, 1812. This is sufficient proof that the book was widely read. As a proof that Gillray's caricatures were not the only inspiring publications during that period of national despondency the following extracts from a review of Pasley's Essay by Robert Southey in the *Quarterly Review* for May, 1811, will sufficiently indicate.

Southey, as the author of the *Life of Nelson*, must have rejoiced to find that the spirit of his hero was still alive in England:

"An author has now come forward with the spirit of a soldier, and the heart of an Englishman, to enforce upon us the conviction that the struggle is for our existence, and to show us how it may be carried on to a triumphant end."

o o o o o

"We cannot better perform our duty to the Public, than by laying before them a summary of this most interesting book, and endeavouring to support the general opinions of its author by a view of the actual strength of the British Empire, so consolatory, so proud, and so unanswerable, as to put the lily-livered crew of our *husbanding* politicians to shame."

o o o o o

Digitized by Google

"But we had already exceeded the limits which we had proposed to ourselves, and we must hasten to a conclusion by a short summary of the reflections to which Capt. Pasley leads us. Peace with Buonaparte, or with France under any other ruler, while France possesses its present extent of coast, it is folly, or frenzy, or treason to advise. To carry on a defensive war is to remain stationary in power, while our enemy is increasing in strength.

This also is demonstrably the certain road to ruin. We have an efficient regular army at this moment, of upwards of 250,000 men. If we could lay this island alongside France what then should prevent us from doing it as resolutely as Nelson ever brought an enemy's three-decker to close quarter? What should deter us from meeting Buonaparte anywhere with equal numbers—from casting the liberties of the world into the scale, and trusting to God and our good cause and our own right hands for the triumphant issue? But we are masters of the sea—uncontrolled, undisputed, absolute lords of the whole ocean. It is in our power, therefore, to choose the vantage ground, and to attack the enemy whenever and wherever it is most advantageous for us, with such a force as shall ensure success, were there even no superiority of courage on our part, and if people whom we go to deliver were to be passive spectators of the contest. With such a force, with such means of augmenting and such resources for supporting it, knowing too, what even the most panic-stricken of the tyrant's flatterers in this country dare not deny, that wherever our troops have been fairly tried against his Invincibles, they have uniformly beaten them, what is it that can have occasioned the absurd and mischievous feeling of dismay, which gives ear to any voice rather than the voice of hope, to any counsels rather than those of true patroitism, true courage, and true wisdom? This is a subject too wide and too important to be lightly glanced at. We should be glad to pursue it; but we can only at present in a few words illustrate the principle of *husbanding* our resources, which is the watchword of the despondents, and then conclude.

By this precious phrase, it is meant that we ought to save our men and our money till we are actually invaded by the enemy. Now of the policy of husbanding money with such a view, we have an illustrious example in the Greeks of Constantinople, who hoarded up those treasures to be plundered by the Turks, which they would not employ in carrying on the war against them, and the equally wise policy of husbanding an army has been exemplified in our own days by Prussia. Prussia had an army of the 'best disciplined troops' in the world; they were the admiration of all Europe upon the parade, and they had once been the terror of Europe in the field. But the present army had been *husbanded;* the consequence was, that in the hour of trial they came to the field like raw militiamen opposed to veteran troops; and in a single day the Prussian monarchy was overthrown. The event of the Battle of Jena might have been predicted with perfect certainty: for in military science, as in every other science, art, or trade, practice is essential to perfection. The prize-fighter improves both his skill and his muscular power by daily trials and exertions; the more he uses his arms, the more tremendous is the blow

Digitized by Google

which he is able to give with them; while the Hindoo devotee, who sits with his hands before him in the same posture of devotion for weeks and months together, husbands his muscles till he loses the use of them! 'Oh woe to thee when doubt comes on!' says a wild German writer; 'it blows over thee like a wind from the north, and makes all thy joints to quake.' Woe indeed will be to the Statesmen who doubt the strength of their country, and stand in awe of the enemy with whom it is engaged! and woe be to us and to Europe whose deliverance must come from us, and to liberty, and knowledge, and pure morals and true religion, which with us must stand or fall, if the Government of this mighty country, in these momentous times, should be entrusted to men,

> 'Who talk of danger which they fear,
> And honour which they do not understand!'

We have been told of the danger of Lord Wellington and his army in language which it is humiliating for an Englishman to read as coming from an English press—language as base as the basest political cowardice could inspire, and as mischievous as the foulest treason could have dictated. But not such is the feeling of the nation. What if the tyrant himself should come with a new army of the north and his legion of honour, to put in execution his old boast of driving the English into the sea? On the banks of the Tagus we can assemble a British force sufficient to cope with any that he can bring against it; and we can supply it there. Would to God that he would come! One effectual victory, one thorough success pursued to the destruction of an enemy's army, commanded by him, and oh what a spirit would be kindled throughout Europe! nor would the effect which would be produced at home be the least beneficial of its important consequences. We have not yet as a nation learnt to think highly enough of our power. We must exalt ourselves if we would not be humbled by our enemy. This maxim has been established by Capt. Pasley. We have no hesitation in affirming that this book is one of the most important political works which has ever fallen under our observation. To the ability with which it is written we repeat our already frequent testimony; to the object it proposes we give our unmixed approbation; and though we frequently differ as we have shown, in the degree to which they ought to be carried, we cordially admit the general validity of the principles which it inculcates," p. 435.

The above criticisms, it must be conceded, constitute very high praise. The *Quarterly Review* was at that time largely under the control of Canning, and was mainly inspired by him. Canning, as a disciple of Pitt, and the originator of the bold coup in 1807, by which the Danish fleet was captured, at the moment when Napoleon's power was almost supreme over Europe, must have hugely enjoyed Pasley's breezy Essay.

That the vigour of his writing was quite up to the level of the

Digitized by Google

vigorous policy recommended by him will be appreciated after reading the following extract from Pasley's Chapter IV., treating of "Martial Policy."

"All nations must, at some period or other of their history, incur the kind of necessity which we have been describing; the necessity, of either basely sinking into a conquered province, or of becoming warlike and ambitious. But woe be to the nation, which either does not or will not see that necessity, until its case becomes almost hopeless. If my reasoning in the preceding chapters be correct, that necessity, which we have hitherto felt only by halves, will soon come fully home to the British nation. The time is arrived, or is rapidly approaching, in which we may find that our warlike and ambitious views, if confined to the ocean alone, will not be able to protect us; that our system of warding off our adversary's blows, and screening ourselves behind our wooden walls, will no longer save us from destruction; that like other great nations, which have preceded us on the theatre of the universe, we must become a warlike people by land as well as by sea; that we must, in short, conquer upon both elements, or in all human probability we shall, on both, be conquered.

The mercantile ideas, the notions of the great importance of commerce and manufactures, that became generally diffused throughout this nation, about the beginning of the last century, might of themselves have completely extinguished our martial spirit, and made us exclusively a nation of traders, like the modern Dutch, destitute of every sentiment, but the grovelling wish of acquiring wealth; and we, with our wealth, must soon have fallen a prey to some poorer and more warlike neighbour: if our commercial pursuits, which set the interests of our merchants at variance with those of the merchants of other countries, had not fortunately led to national quarrels, and involved us in wars from time to time. Our policy in conducting these wars, which arose out of the mercantile spirit of the nation, was to aid our continental allies by subsidies alone, or with only a very small portion of our military force; using every exertion to fit out powerful fleets, by means of which we could ruin the enemy's commerce, and employ the greatest part of our land forces in robbing him of his colonial possessions.

As long as the continent of Europe was divided amongst a number of independent states, none of which singly was much superior to us or to its neighbours in strength; and of which even the smallest and weakest were, to a certain degree, safe, owing to the jealousies of the greater powers, this policy was as good as any that we could have pursued. Under this system, not only our colonial and naval power, but our commerce and manufactures, equally prospered. We have been favoured with the custom of all nations; and whilst we glory in the thought that our ships rule the ocean, we reflect with almost equal exultation that our cloth and our buttons adorn the bodies, and that our cutlery is to be found in the hands of Negroes, of Tartars, of Europeans, and of Americans. Whilst this vigorous system of colonial, commercial and naval policy was

Digitized by Google

gradually coming to perfection, the splendid valour, that has always characterized the British nation, rendered any portion of its armies, however small, of considerable weight, whenever Government chose to throw them into the scale of continental warfare. Hence our arms were formidable in Europe under King William and Queen Anne, and even till after the middle of the last century: but soon after the commencement of the last war, when the balance of power upon the continent of Europe began to totter, and latterly since it has been completely destroyed by the superior energy which the French acquired by acting, in war, upon new principles, whilst all other nations persisted in following the beaten track; our own system of national policy gradually began to degenerate from good to indifferent and it has at length become no longer suited to the circumstances of the world. It has become completely inadequate for any grand or permanent object, which we can propose to ourselves to effect. It is even inadequate for the preservation of any of those darling objects of our pride and ambition, which under former more favourable circumstances it was the means of obtaining. We must therefore either adopt a new system, suited to new times, or perish.

If we wish to preserve the naval superiority, the commerce and manufactures, which God who inspired our ancestors with the wisdom, vigour and industry necessary for obtaining them, has placed in our hands; we must no longer look upon our armies as a secondary consideration, and our wars by land as a mere pastime, in which success, good or bad is almost a matter of indifference, provided the sea flow between us and the scene of action. We have an arduous task before us. It is no less than to overturn the great continental empire, which threatens our destruction. A necessity, that will brook no ordinary measures, strongly urges us to the attempt: and if we set about this noble enterprise with the spirit of men; if we make the attack on this colossal power, before it is well knit together and firmly consolidated, whilst anger and revenge yet rankle in the hearts of the great mass of population of which it is composed; and if we transfer to the conduct of our operations by land, the same wise and vigorous system of policy which has made us by sea almost invincible; there remains, in my mind, little doubt of our ultimate success.

But until we adopt a more enlarged system of martial policy suited to the present times; till we shall shake off with disdain the narrow or dastardly spirit, which would confine British valour and enterprise within the limits of what, with a mixture of overweening presumption and of unmanly humility, we have been pleased to style our own element; till we shall send forth our armies to fight the enemy on the banks of the Ebro, the Elbe, or the Loire, with as much confidence as we believe we should feel in fighting upon those of the Thames; till we plant the British flag on the mountains of Sicily, on the Apennines, or on the plains of Champagne, with the same undaunted hearts, with which we now display it on the ocean, or on some beggarly rock that is encircled by its waves; till we come forward in the face of the universe, with a view to the applause of the present and of future ages, and, throwing the gauntlet to

Digitized by Google

our adversary, boldly challenge him to meet us hand to hand in any part of the known world; it is my opinion, that we shall see all the efforts of our armies, whilst we remain a nation, terminate, as they lately have done, either in disappointment or disgrace; and this, I confess, might be of little importance, at least so it might be considered by men who are indifferent to the glory of their country, if it did not appear almost self-evident, that upon these efforts, sooner or later, our existence must depend.

From the want of this daring spirit in our national councils and policy, all our failures, all our disasters by land have arisen. Yet we scarcely find one political or military writer, who has yet gone beyond the secondary causes of the bad success of our armies. At one time it was supposed, that the British soldiers were inferior to their adversaries; and thus the bravest men in the world were stigmatized with undeserved contempt by others, who never looked danger in the face. Now that their incomparable valour has, by repeated victories, under every disadvantage, over the conquerors of the rest of Europe, burst through the cloud of obloquy, and shone forth conspicuous to the world like the noonday sun; men have been obliged to guess at some other cause. And accordingly, at a time when our naval heroes fill the world with their fame, the race of Peterboroughs and of Marlboroughs on shore has been supposed to be extinct; just as if heroic leaders can possibly be wanting in a country that produces such valiant men; or as if heroism were of a particular element, and a British chief, before he possessed it, must be some years immured in the gloom of a cockpit. Others, who allow the superiority of our troops, and that we have generals fit for commanding them, throw all the disasters our armies have incurred, upon the defects of our commissariat, or of some other unfortunate military department. Others again, particularly the opposition for the time being, attribute every failure to His Majesty's Ministers. When some continental expedition of ours (as they have done in general) arrives too late to effect its object; when the country, which it was to have defended, is found all ready overrun; or the allies, whose cause it might have retrieved, are conquered; then a grand outcry is made against the neglect and misconduct of Ministers, who are alone made out to be the guilty persons, the cause of the dishonour of the British arms, and of the downfall of nations. Not only are they charged with things, for which they ought to be considered responsible in their official capacity, but with all the errors and misconduct of their inferiors; with everything, in short, that can afford matter of regret or of censure; and no allowance is ever made for the unfavourable circumstances, under which, they may, at times, have acted.

Now as we have seen that these complaints, and these failures have been general, whoever is Minister; that men of the most opposite characters, parties, and views, have guided the helm of affairs, and that all these men have uniformly prospered in war by sea, whilst, on the contrary, the expeditions by land, which they have planned, have either failed, or even the most brilliant victories have led to no permanent

Digitized by Google

benefit; it is evident that neither our naval successes, nor our military disasters, are exclusively the merit or the crime of any one administration; that, in short, no change of ministry will ever bring a remedy, until, as I said before, we adopt a more manly and enlightened system of martial policy.

When such a system is once adopted, all the secondary, though serious, causes of our disasters will be either entirely done away or rendered less hurtful. We shall find that the British constitution in its present state, is not only the best form of government, for promoting the happiness and wealth of the subject, but the best and most vigorous in every kind of warfare. We shall find, that no ministry can be formed, which will not be capable of supporting the honour of the British arms by land, as well as by sea: they will do it upon both elements or on neither."

The last paragraph of this extract, in which Pasley expresses his opinion as to the efficiency of the British form of government, is based on the study in a previous chapter of the comparative efficiency of the republican and despotic forms of government considered with reference to the conduct of military operations. In Pasley's opinion, the British form of government, as it existed in 1810 exhibited a due proportion between the principles of Aristocracy and Democracy, and was eminently well fitted for carrying on a war with vigour. Throughout the Army, Pasley's Essay was enthusiastically welcomed.

Sir John Stuart, under whom Pasley had served at the Battle of Maida wrote to him from Malta on 31st March, 1811: "Your work, of which only the copy you sent me has as yet reached Messina, was borrowed from me for perusal with great solicitude. You will readily believe that there are none of your military readers in this part of the world who do not feel the force of those remarks which you have so ably combined and expressed in the course of your pages."

Major John Squire, who died from the effects of over-fatigue on active service at Truxillo in May, 1812, wrote in December, 1810: "I hope the book will have the desired effect, and open the eyes of our Ministers, who seem to look upon success in war as a secondary consideration."

Capt. Jones—afterwards Sir John Jones—wrote from Castaña on the 12th January, 1811: "You cannot imagine how much your work is sought after in the Army. Lord Wellington reads it; Marshal Beresford reads it, in short it is universally read among us, and as universally admired. . . . It will require a few years, and the labours of public-spirited men to bring the public mind to a just sense of its own interest. Continue your successful endeavours to enlighten us, and I shall not despair of seeing England a conquering nation."

Capt. Burgoyne, as might have been expected, wrote most warmly from Vizan in April, 1811: "I am delighted to hear of your book; it is what I have always wished for you."

Digitized by Google

Major Charles Lefebure, originally the inspiring leader of the group of young and enthusiastic R.E. officers, had been killed at the assault on Matagorda near Cadiz on the 22nd April, 1810, just six months before the book was published. Otherwise we may be sure he would have written as warmly as Squire, Burgoyne, and Jones.

But it was not only in the Army that the book was received with enthusiasm. One of the Miss Malcolms of Burnfoot, a cousin of Pasley's, writes: "I hear with the greatest pleasure that the reputation of your book continues to increase. Mr. Thomas Telford (the celebrated engineer) passed a day here last week. In his public line he has access to the opinions of leading men in the House of Commons. The warm manner in which he expressed himself on the subject of your publication gratified me more than words can express. . . . Mr. Telford says had you been a Frenchman, Buonaparte would have put you at the head of his army."

Needless to say, all criticisms on Pasley's book were not equally enthusiastic: "This young officer," writes a sneering critic in the *Monthly Review* for August, 1811, "we understand, served for a short time in Spain; and it is singular that he seems to have imbibed on that unsuccessful service the notions of a conqueror."

It was well for the British Army and the British Empire in 1810 that the spirit of Nelson was not dead, and that we had an officer of the land service who possessed so large a measure of Nelson's enthusiasm and energy as the young lieutenant of Engineers who had dined on board the *Victory* in 1804.

The spirit of our military policy from 1810 to 1815 was as different from its spirit as seen from 1793 to 1810, as the spirit of Nelson differed from that of our commanders in the Walcheren expedition.

That Pasley was a great organizer, his work at Chatham, where he was Director of the R.E. Establishment for 29 years, sufficiently attests. He would never however have been able to accomplish the work he did had he not been loyally supported and encouraged by his group, and unless in the second place he had received support outside the Corps from Lord Wellington. "No corps," as Pasley says, "can improve itself," and it was due to Wellington's urgent appeal after the assault on Badajoz on the night of the 6th—7th April, 1812, that the R.E. Establishment was instituted and the Corps of Royal Sappers and Miners called into existence.

Pasley had recommended that the *Military Artificers* should be called *Engineer Soldiers*; but this was not accepted, and the men were called *Royal Sappers and Miners*. It was not until the efficiency of the Corps in the Crimean War had proved the value of Pasley's system of instruction, that this reform was carried out, and the officers and rank and file of the Corps finally amalgamated under the common title of *Royal Engineers*.

Digitized by Google

Pasley however not only proved himself a great organizer by his work at Chatham, but he deserves the title of Organizer of Victory in the sense applied to the great French Engineer Carnot, on account of the influence on the national policy produced by his famous Essay.

Here again, in doing honour to Pasley, we do well to remember how much we owe to Lefebure, Squire, Burgoyne, and Jones, all of whom encouraged and supported him in his work. Pasley's group, no less than Nelson's band of brothers, deserve to be remembered when we desire to honour the work of their leader. Absence of self-seeking, and single-hearted devotion to the Service were equally the characteristics of both groups, and of each it may be said with equal truth :—

> "Whether their fame centuries long should ring,
> They cared not overmuch;
> But cared greatly to serve God and the King,
> And keep the Nelson touch."

Digitized by Google

A LADY'S EXPERIENCES IN THE GREAT SIEGE OF GIBRALTAR (1779–83).

BEING THE DIARY FROM 1ST JUNE, 1779, TO 13TH JUNE, 1781, OF MRS. GREEN, THE WIFE OF LIEUT.-COLONEL GREEN, CHIEF ENGINEER OF GIBRALTAR (AFTERWARDS LIEUT.-GENERAL SIR WILLIAM GREEN, BART., CHIEF ENGINEER OF GREAT BRITAIN, 1786—1802). EDITED BY COLONEL E. R. KENYON, R.E.

(*Continued*).

Sund 13. Westerly wind. We find every Body full of anger and Vexation from Yesterdays business. I came into Town to dine and by desire of the Col am to come In to remain till the great Heats are over. I return to the Mt at Night. 13th August, 1780.

Mond 14. Westerly wind. The Flagg of Truce not appearing!

Tuesd 15. Westerly wind. The Flagg came about Noon. The crew of the *Dolphin* Brig is arrived too and all safe except one man who had his arm broke by a splinter. The men in the Boats were not very civil to them, but Admiral Barcelo was exceedingly kind to them, at the same time expressed his Wonder that our Boats had not been sent out. He made the Captn a present of 70 Cobbs and told him He was under the Necessity of putting down in his Journal of what Prizes was taken by them that this Brig was taken within Gun shot of this Garrison. The officer of the 56th is come over, and the Merchant as they call'd him proves to be a Mr Hamilton, Husband to the Woman who was hurt in the Leg by the only shott which has as yet come Into the Town from the Enemy, on Jan the 12th. The Woman who is also come over, proves to be the sister of Mrs Hamilton, Widow of Serjant Gray of the Artillery, a smart Looking Person who says that Admiral Barcelo was exceedingly Polite and kind to her. She had several letters for this Garrison but they were all taken. The officer did not Lose any of his Baggage. The Vessel was coming Here with Bale Goods and many Necessaries for different Merchants here, had only been 11 Days from Plymouth. All this seems to add to the Distress of the Garrison. One only Comfort is that the Small Pox seems to be Dieing away. Indeed it was Dreadful to hear the Daily Losses. More than 500 have Died. The Smallest Number has been of Soldiers, as there has not been more than 50 Died, but their poor Families are greatly thinned, and their Grief is great at not having been allow'd to Innoculate. It might have saved the Lives of Scores. Therefore it is a very great Distress to think of this Misfortune.

Digitized by Google

16th August, 1780.

The 16th and 17th I remained at the Mount. The weather Violently Hott. Nothing particular pass'd in these Days and I came into Town on Friday 18th in order to Remain some time. The Weather very Close and Uncommonly Warm. Find myself rather Lame in Evening. Mr Cordoza Died. Col Mawhood taken Dangerously ill.

Saturd 19. Westerly in the Morning. Violently Warm. Find great pains in my Limbs. At Noon there seemd an Easterly wind. It proved so and Blew hard in the Evening. 2 of our Men of Wars Guard Boats went off last Night to the Enemy, 16 Sailors on board!

Sund 20. Easterly, Dull and foggy. Am not quite so Lame as yesterday. The greatest difficulty now to provide for a family. We got as a very great favour 20 chicken this Day, 27 Dollars, and 12 Ducks for 20 Dollars. This Day continued exceedingly Warm and Close, Col Mawhood very bad. Our 2 Gun Boats went out in Evening. We had been firing at the Enemy's Boats from our Batterys at Europa and drove off two Galleys. One who had been Driven in too close in the Nt and had come to an Anchor was obliged to leave it behind.

Mond 21. Easterly and Foggy as Yesterday. Find myself quite Lame and affected by the Weather. Go to Capt Phipps in Evening. Cheese is now 1 Dollar the pound, sugar 1 Dollar, and any tolerable tea 6 Dⁿˢ. This Day there was a meeting at Mr Power's House. A Remarkable dinner this Day, given by Col Ross in part, he sending an English Sheep to the Master of the Assembly House. It ended in great Noise and Riot. The Company was not very Numerous, only 21 Gentlemen.

Tuesd 22. Easterly wind, Close and still Warm. Find myself rather Worse for being out last Night. Mrs Gray Here to Day. Had some few Gentlemen to dinner. An English Shoulder of Mutton from Mr Power. I mention that from the Rareity. It was *in* exchange for something We had to spare. A pretty Large party *in* Even. Every thing now growing Dearer and Dearer.

Wed 23. Easterly and foggy. Very Lame to Day, could not get up to Breakfast. The Articles of War was read to the different Corps this Day. Upon the Parade of the 39th something very disagreable passed. The Lt Col, Colonel Ross, went there Under a Visible agitation; after the Regt was Drawn up He ask'd if Genl Boyd as Commanding officer of the 39th was upon the Parade. He was told Not. He then order'd the articles to be Read, after which to the surprize of every body He address'd the officers and soldiers, talking first of the True Meaning of those articles and afterwards attacking the Colonel of the 39th calling him Bob Boyd, and the Regt the Storekeepers Regt, and said a vast deal tending to hurt Genl Boyd in the Eyes of the Men; and He also order'd the Adjutant to tell the Genl all he had been Saying! but as He declin'd it one of

Digitized by Google

the Genls Aid de Camps did. It is Supposed this will occasion much Confusion. Colonel Mawhood is thought past Recovery. He is as bad as possible. He was only taken ill with a Complaint in his Bowells upon Thursday the 17th inst. He had dined at a Wager Dinner given by Col Picton upon Tuesday the 15th. The Night before had been at Phipps, and the Evening after at Major Fauncourt's, and this Complaint came on very suddenly. He took some trifling things of himself at first, but sent for his own Surgeon directly, and Dr Baynes also was with him upon the Thursday, so no time had been lost. This afternoon it was the most Uncommon Heat that has been for many Years, Therm[r] at 93½ and at 10 at Night, 82. 23rd August, 1780.

Thursd 24. Easterly. Close and foggy as yesterday, tho' not quite so Hott. Very Lame this whole Day. Every Body is full of what pass'd upon the 39th Parade. Mrs Rogers with me this afternoon. Col Mawhood as bad as possible. Col Ross put Under Arrest this Evening by Lt Genl Boyd. The Small Pox seems now quite over.

Fry 25. Easterly wind. The Line of Battle Ship left Algeziras this Day and went towards the West. Barcelo fir'd three times this Day on account of its being St Luis, the Name Day of the King of France and Princess of Asturias. Find I have got great cold coming in my Head.

Saturd 26. Easterly wind. Blowing hard all Night. The Col Breakfasted at the Mt. I did not go as being Unable to get up. Col Mawhood alive but totaly given up. Col Ross in Orders for a General Court Martial on Tuesday Next. Colonel Green President, 1 Lt Col, 5 Majors, 6 Captains! This Day a small Vessel (or rather Boat) arrivd from Minorca in a few Days, brings very few supplies or News. The Gov[r] has a few things sent as a Present from Genl Murray which He says He shall send to the parade to be sold by auction and will not be a purchaser himself. The Gov[r] has a Declared dislike to having presents made to him. Indeed He is very little Try'd that way. It will be rather hard if He makes it a point with officers that may fortunately have a family Necessary sent to them, at such a scarce time as this. It is to be supposed He will change his Mind on that Head. Col Mawhood still alive but in a Dreadful Way.

Sund 27. Hardly any wind. Violently Hott. Col Mawhood still alive; and tolerably Easy. Col Green had a Tooth Drawn this Morning. This turn'd out rather a pleasanter Day with regard to Heat than any of late. I did not stir out, not being as yet well enough. A good deal of discontent arising about this Court Martial, particularly between 2 of our Captns of Engineers; (one being in orders for a Member) and it came to Captn Evelegh's turn. He pleaded his being Aid de Camp, but as there never had been an overslaw ordered for him it was impossible to avoid returning him to

Digitized by Google

27th August, 1780. the Adjt Genl. However the Gov^r instantly ordered the overslaw! and Capt Phipps was to Sit.

Mond 28. Westerly wind. Warm Morning. Col Better; and I went down to Breakfast. Colonel Mawhood has had a bad Night and is going into a very bad Alarming Way, Something nearly Despairing &c. This morning 2 young officers of this Garrison, Mr Stephens of 39th and Mr Johnson of 56th went out to the windmills in order to settle an Idle business, merely the Effects of their being Young Men. They were parted; and the affair is to be Settled by Commanding officers. A more Serious Matter passed upon the South Parade yesterday morning between the Gov^r and Lt Col Making. This Evening Doctor Baynes call'd and acquainted Us of the very bad way Col Mawhood was In, and telling Us it was not possible for him to hold out many hours. He had made two Alarming Attempts, proceeding it is supposed from Delirium,—one, of some *Nails*; one of a Bathing Tub—Every body is concerned; as He is a very Worthy Man and exceedingly well Bred and Gentlemanly in every Respect. He has not been well from the first of his coming to the Garrison in Jan.

Tuesd 29. Westerly wind; the Col getting ready for the Court Martial. Capt Pigot of the 56th had wanted to sit in the Room of Capt Price of that Regt! It was an odd desire, but had been complied with Yesterday! However this Morning it was changed to the first orders, and the 6 Captains were positively settled as follows,—Capt Phipps, Engineers; Capt Eyre, Royal Artillery; Capt Perryn, 12th Regt; Capt Price, 56th Regt; Capt Lindsay, 73rd Regt; Capt Shand, Royal Artillery. The above is according to Dates of Commissions. The Court consisted of Colonel Green, Lt Col Craig, 56th; Major Fancourt, 56th; Major Hallows, 56th; Major Dawson, 58th; Major Horsfall, 72nd; Major King, 58th; and the six Captains. Col Mawhood died this morning, was Open'd at Night. A Mortification in his Bowels had taken place, and likewise a Stone as large as a pistol Ball was found in his Gall Bladder. It was no wonder He had been long ill and oppress'd. As the Doctors agree, He could not have been in any Health or Spirits for a long time past.

The Court Martial assembled at 10. Colonel Ross went attended by Lt Col Kellet, Major of the 39th, and the Adjt of the Regt. Lt Genl Boyd went in his Lt Genls Uniform with his Aid de Camps. The Court went over for the Day at 2 oclock. The same two young Gentlemen that went out Yesterday, went out again this Morning, attended by Seconds. Mr Stephens Pistol shot away one of Mr Johnson's Waistcoat Buttons and part of his Shirt but did not hurt him.

Wed 30. Westerly wind. This Morning a Small Boat, with 5 Men, came over from Tangier with a packet from Mr Logie to the Gov^r containing very Unwelcome News; by which we learn that all

Digitized by Google

Communication between Us and Barbary is Stop'd, and in Consequence We cannot expect any Supplies. The Court Martial Meet again. Col Mawhood Buried this Even ; the Ceremony as follows— The whole 72nd Regt with their Colours and Arms as usual on such occasions, Under Major Horsfall's Command. They form'd a Lane from the Colonel's House to let the Corpse pass through. The Govr was Chief Mourner, his four Aid de Camps walking first, the Adjt Genl and Qr Mr Genl on each side of the Governor, Every officer off Duty in the Garrison. Lt Genl de La Motte walked at the Head of the Brigade of Hanoverians. The Pall Bearers, Colonel Green, Colonel Picton, Colonel Godwin, Lt Col Cockrane, Lt Col Trigge, Lt Col Mackenzie, Lt Col Craig, Lt Col Kellet, all with Crapes round their Arms, and all the 72nd with crapes, which they wore about a fortnight afterwards. N.B. Many Ceremonys were expected, but for what Reasons were omitted no Body can tell ; it not being as yet known who had the Direction of the whole, tho' in part it is Guess'd at. Genl Boyd was not there or at the Court Martial to Day. Capt Lesley of the *Enterprize* Frigate paid a very handsome compliment to Colonel Mawhood Corpse, as He had Minute Guns fir'd from the time The Body mov'd to its being Buried, and all the King's Vessels had their Colours half-staff. The Colonel was Buried at Southport ! It was expected he would have been in the Church. 30th August, 1780.

Thursd 31. Easterly wind. A Close Damp Day. The Court Martial meet as Usual, and it was expected that Colonel Ross would have come upon his Defence, as He had begun on that head yesterday. He was then desired to say if he chose more time, but He said He was perfectly ready. However this Morning He had changed his mind, and after reading a long paper and Relating some past Circumstances respecting an old Regtl Coat which He had Worn for these first 2 Days of the Court Martial, and which was only to bring In what passed between Himself and Genl Boyd 5 years agoe ; (for so long has a coolness subsisted), He then desired the Court to indulge him for two Days. As that would bring it to Sunday He was told the Court would therefore adjourn to next Monday. N.B. He was Dress'd properly this Day and told his Reasons for not having been so the other two Days. Genl Boyd was not there. It is much to be wish'd that things had not been brought to this length. It is hardly to be suposed they will now ever be properly settled. It is the opinion of many that Colonel Ross would rather chuse to have this Dispute settled in a more *personal* Way. It is so much more Deeply Fix'd as it has been so long coming on, and on the Col's part seems a total Disregard and a poor opinion which He has thought proper to form of the General, who in course has shewn himself the Commanding officer of the 39th, in fact there seems a fix'd Mutual dislike,—and it is realy a pity. N.B. I have omitted as yet to mention the charge

Digitized by Google

31st August, 1780. given in by Genl Boyd. It was that Colonel Ross had spoken disrespectfully of Genl Boyd at the Head of the Regt and had shewn an Intention to hurt the Genl in the Eyes of the Officers and Soldiers of the Regt, as his Discourse tended to that purpose.—I may not be exact as to the Words, but the above is the Substance. N.B. It was by every Body thought a very Mild charge, all things Considered, as there was some parts of the Colonel's Discourse that evening at the Regtl Parade that might have turned greatly to his own Disadvantage.

Fry September 1. Easterly wind. Dull Close Morning. The few remaining Vessels that We had were expected would sail as last Night, but they did not. People begin now to be very Uneasy in the prospect before us, and it is much to be feared that the Troops will show their discontent. It seems almost impossible for any Ships to get out as the Enemy have a constant Line of Boats and other Vessels from Ceuta to Caberitta.

Saturd 2. Easterly wind. More and More Complaints about fresh and Salt Provisions &c. Veal has been sold at 10 Rials the lb. We gave to Day 3 Cobbs for the Qr of a Hill Kid which weighed a little more than 5 lb. One fortunate thing is a great Quaintity of Fish are now brought In almost every Morning, which is a great comfort to the poor men and families.

Sund 3. Easterly wind. Exceedingly Warm Close Weather. The Colonel Breakfasted at the Mount, as did Charlotte and two of the Women. I did not go. Find myself very Low and dull and still Lame. Had a Leg of Veal to Day, 12½ lbs at one dollar pr lb! Upon the whole every one seems uneasy. A man of the Artillery Died rather Suddenly. He only went into the Hospital on Saturday, and Died this morning. Inflamation in his Breast. We had some Gentlemen in Evening and in Conversation I heard of a circumstance which I had never been inform'd of by the Col: which was that the Govr had accepted Some Grapes from Mrs Godwin and a Melon from Major Barlow. It so happen'd that Col Green was present at both the times when the Govr thank'd those Gentlemen for their presents, but at the Same time he Seem'd to look rather Confused when he found the Col was close to him. N.B. Oranges.

Mond 4th. Westerly wind. The Court Martial meet again. Col Ross was Dress'd and appeared cool,—said he Did not mean to Depreciate Genl Boyd "but only to put him to his true Standard;—just as We do to Good or Base Metal. We always chuse to prove our Coin,—if it turns out of pure Gold in its quality it is the more Esteem'd—from having gone through the Trial—but if otherwise, We know it and always look upon it as Base Metal."

The above and Many other such like Speeches He made. He very freely and openly confess'd that He had said all and every thing which had been mentioned by all Genl Boyd's Evidences such has

Digitized by Google

having call'd the General "Bob Boyd—For he knew the Genl was a man of Humour and liked to be free with his Superiors; nor could He conceive any harm in calling the 39th the Storekeepers Regt, as every Body knew Genl Boyd had been a Storekeeper." N.B. When Genl Boyd, on the first Day's Trial (the only one of his being present) gave in his charge or was examin'd He seem'd a great deal affected and said it was hard for him at such a time as this to appear as a prosecutor against his Lt-Col, but He beg'd leave to observe that He Glory'd in having been Storekeeper, that He had Carried Arms long before He had the Honor of being either Storekeeper or Judge Advocate, and He thought himself a very fortunate Man when he was appointed to those two Departments. Genl Boyd refused a Seat which was offer'd him. 4th September, 1780.

The Sentence of Court Martial—A Suspension of Twelve Months and render'd incapable of ever Serving in the 39th Regt. The Governor took off Nine Months of the Suspension and mitigated the Later part! This seems a pointed partial business and has rather Hurt the Members of the Court Martial. Every person seems more or less affected at this and the Regt seems very Uncomfortable. The Court Martial is again Sitting, upon a Soldier of the 58th for taking charge of an other Soldier's Musket as he was standing Centinel at the South. The other man is an Hanoverian and has been detected some Days before in Stealing some Money from one of his Mess Mates. He ask'd the Man of the 58th to hold his piece just for a Moment. This it seems is often done. But He made to the Line Wall, with an Intention to get over, was there stop'd. He is to be Try'd by their own Law. Our Man is one of exceeding good character and is well liked by all his officers. The Sentence is not known.

Wed 6th. It rained this Day for the first time this Season. It Cool'd the air. The 17th Hundred part of an Inch of Water fell. The Court Martial was dissolved this evening. The Colonel much indisposed. Very large Straw Heaps now made up, by much Larger than Ever,—and also over at Algezira. We had a very fine Hind Qr of House Kid from the Coxswain; for which We paid 1 dollar a pound! The Qr Weighed 9 lb.

Thursd 7. Westerly wind. Col not at the Parade. The Man of the 58th was Brought down at Guard Mounting in order to hear the Sentence of the Court Martial; which was to Receive 500 Lashes, but in Consideration of his good character He was recommended to the Gov^{r} by the Court and He was in consequence forgiven. Colonel Ross is put out of Arrest and made acquainted with the Sentence of the Court Martial. N.B. No Sentences are ever put into orders, and this is the first that has been made any way public since Genl Eliott came to the Garrison.

Fry 8. Westerly wind. Close Morning. A Man of the 39th Received 300 Lashes upon the Grand Parade this Morning for

Digitized by Google

8th September, 1780. attempting to Desert. In the course of last Night 2 men of the 56th deserted. The Col rather better, changed his apartment yesterday. He took a third of James Powders in the evening. He had a good night. His room is next the Garden and is a very Delightful Airy Bed Chamber.

Sat 9. Easterly Wind. Col not at the Parade. Very Busy all of Us in Moving the things from out of the Drawing Room into the Large New Room. Find myself a good deal Dejected and Low in Spirits. A great deal of talk of the Govrs Management Relating to the late Court Martial as he has Undertaken to alter it in all points. A Bomb Proof (which was begun in the Month of August) making under the Garden in the Town Quarters, is in good forwardness. It will be a very useful place in case any Bombardment takes place; it is done by Diging under the Garden; which is very high above the Level of the Street. The opening is just opposite our Dining Parlour, in the Front Court. It will consist of three apartments, and it Runs deep In. In the further part, near to the Coach House Yard (which is also next the Street) is an apartment just long enough to hold a small platform and has a Window, large enough for a man to get through which may be Useful in case of any quaintity of Rubish should come into the Court Yard. The Top of this Bomb proof is cover'd over with many well prepared coats of Hardend Clay &c &c well Ram'd down and finish'd as Usual with such Buildings. It is about Nine feet Thick. If this is never Wanted as a Bomb proof it will be capital Cellars. It has added to the Look of the Front Court, opens with 2 Doors, between which are two Bulls Eyes; and the Doors are folding ones. It has a very good appearance. It is a Work of much Labour, attended by plenty of Uncommon Noise, Raming down, and Corking, all amongst the Heavy Oak Timbers &c. The Noise is not of any Consequence; when we think how Essential it may be hereafter. It is so handy by being near the Colonel's House, by affording him the means to throw In his papers or whatever else He wishes to have at hand for his Use. N.B. A Number of Signals made last Night from Admiral Barcelo and from the Camp and Queen of Spain's Chair. It was the whole Night long.

Sund 10. Westerly wind. Fine Morning. All pretty Well. The Colonel not at Grand Parade. He took a second dose of James Powders, which I increased to half a paper. It had no effect till near five in the Morning and it then threw him into a pleasant Perspiration; and he slept till near 8. He seems tolerably well now. He went to see Col Ross this forenoon; all well.

Mond 11. Westerly wind. Col at Grand Parade had an Unexpected and Unwelcome Conversation with . . . about Some Workman belonging to the 58th who was employed not where it was Supposed. The Col was totaly Ignorant of it as the man had been discharged from the King's Works since last March. He spoke

Digitized by Google

his Mind very freely to . . . This I am sorry for, as I fear may occasion some Unpleasant Consequences, for I am certain it hurts a Man of the Colonel's temper. It has brought on a good deal of Uncomfortable Conversation amongst the Engineers and has agitated the Colonel. He has spoke his mind very freely to Evelegh. I sincerely wish it had not happened. This evening the Battalion of Saboya went from the Camp and Several Baggage Wagons had brought Parcels from Algezira like Beding &c, and had returned from the Camp with the Same kind of Baggage. 11th September, 1780.

Tuesd 12. Easterly wind. The Col at Grand Parade ; all tolerably quiet. We fir'd a shott or two from Middle Hill at a Boat that was coming too close In. We see that the Enemy have hung some men In the Camp to Day. I am not very well. This is the Anniversary of our firing upon the Enemy, but all has remained quiet from them.

Wed 13. Easterly wind. The Colonel went up the Mountain Early this Morning and Breakfasted at the Rock Guard with a Party of Artillery and Engineers, Captns Loyd, Martin &c. This Day the Bakers were allow'd to bake only a certain fixed Number of Loaves each,—according to an Order given by the Govr. 5 Quadruples given this Day for a Calf ; each qr will weigh about 20 lb. Loaf Sugar is now Nine Rials to the lb—Powder Sugar 7Rs. Tea that used to be 4 Dollars is now 6—and all in proportion Dear and Scarce.

This is the Meeting of American Gentlemen belonging to that Club, to celebrate the Memory of Genl Wolfe. Colonel Green President.* It consisted of 21. All Concluded exceedingly Moderate and Agreable and the Col came home before 7 in evening. The Party which breakfasted at the Rock Guard also Dined there—all except Col Green who came down to the Dinner.

Thursd 14. Easterly wind. A Setee arrived in 20 Days from Minorca. She brings a tolerable Supply of Wine, Oil, Sugar, and Hogs—a few Turkeys too. But all these are to be disposed of Under Certain Restrictions and of course very dear. No one is to be allowed to buy more than one of each kind ; such as one Pig or one Turkey &c. A General Court Martial Sitting this Day. Major Barlow of 12th President—upon a man of 56th found sleeping upon his post.

Fry 15. Easterly wind. The articles of family Necessaries that the Boat brought down from Minorca are to be Sold this Morning at Water Port. We get one Pig, it is small ; will weigh about 10 lbs the Qr. We gave 22 Cobbs, viz., 33 Dollars. This Day 2 Battalions from Algezira March'd to the Camp with flying Colours &c.

Saturd 16. Easterly wind. Nothing very particular in the Camp this Day. The Soldier who was Try'd on Thursday for sleeping on his post Received 500 Lashes this Morning on the Grand Parade.

* Col. Green had been wounded at the capture of Quebec.

Digitized by Google

17th September, 1780.

Sund 17. Westerly wind, pleasant Morning. All Quiet. I went out to pay a few Morning visits,—called at Mrs Goding whom I had not seen for a long time. All well.

Mond 18. Colonel not very well. A few Tents are pitched near the first River.

Tuesd 19. Westerly wind, fine Morning. A Party of Ladies Breakfasted at the Rock Guard! I can not boast of being of that *Military* Set,—and afterwards din'd at Poca Roca Cave. Some Beef in the Market to Day, 6 Rls pr lb.

Wed 20. Westerly wind. The Enemy are working at Some kind of Sand Work on this Side of their Lines, between two Batterys which they formed some months ago. It appears like making a Drain. There is an other Regt come into Camp. All remain quiet as yet. A Parley came this Day and brought a letter from Don Martin Alvarez to the Govr relating to some family letters belonging to Captn Vignoles of 39th and which the Spainish Genl assured our Govr and Captn Vignoles should most punctually be sent In if they ever should fall into their Hands, as they Solely related to a Sum of Money left by his Father to Him. By this Parley we hear that the *Fox*, pacquet Boat, was taken at the time We Suspected it and that her Master and Crew were to come In in a few Days.

Mrs Gledstanes dined with Us. Colonel Mawhood's Auction of Goods &c began as this Day when every thing Sold at an Amazing price. N.B. I must observe that at this time when every family article is so Dear the Exchange is at 38 pence the Dollar, which makes it still a higher price for every article. The cheese is one Dollar per lb—chickens 15 Rials a piece, pigeons 20 Rials a pair.

Thursd 21. Westerly wind. All quiet in Camp. Colonel in the Evening at Genl Boyd's. I seem to Understand that Colonel Ross is highly displeased with the Sentence of the Court Martial, as thinking it a very Severe one. Also so Does Many of a Set in this Garrison who are partial to their Country Man! This afternoon Captn Shand and Mr Seward of the Artillery got leave to Walk out at Landport. The Second Day of Col Mawhoods Sale of Goods. It is astonishing how the Books and any Article sold—meerly it would appear as if it was because they had been Colonel Mawhoods! N.B. The Govr and Genl Boyd had been allow'd to take their first Choice of Books. The Gov also thought fitt to take all the Maps. They were Good ones.

Fry 22. Westerly Wind in the Morning. Col: at Mount and Charlotte Breakfasted with him. This Morning the Enemy began to Dismount some of their Guns at the Artillery Park. They have several Working Parties. At Noon the Wind came Strong Easterly. No sort of Notice taken of this Day being the Coronation. Find I am growing much indisposed and am fearful it will increase. Quite Lame. A Squadron of Horse came into the Camp, supposed by their

Digitized by Google

Uniform to be the (left blank in the diary). A Parley to Day and one Return'd. 22nd September, 1780.

Saturd 23. Easterly wind. Hear all the remaining Ships are expected to sail this Night. I write a long letter to my Sister, as did the Colonel to His son and two Letters to Mr Fisher; one of those last letters went in a Brig belonging to Merchant Anderson—the others and Mine to my Sister went Under Care of Mrs Gledstanes. A Flag of Truce came over this Day and brought a Midshipman who had been taken off one Night about a Month agoe by the Men who went off in a Guard Boat belonging to the *Enterprize*. Some Sailors also came and they all bring an account of the Spainiards having taken a Large Number of our Store Ships; belonging to a West India Convoy; and carried them into Cadiz; and that We had taken 4 of their Line of Battle. This Day a Calf was killed for which the Butcher gave to the owner 140 Dollars...£21. It is to be sold at 10 Rials per lb...4s$^{s.}$ 4$^{d.}$! the Pluck with the Heart at a Pistole...15$^{s.}$ 6$^{d.}$ A Butcher this Morning offer'd to give £200 for 4 of the Oxen employ'd in the King's Works, and 2½ Guineas are given a piece for Young Pigs of 6 weeks old. In fact it is not easy to tell the impositions that are Daily made upon the Army by those Inhabitants who have any Live Stock to sell; nor is it possible to tell the Distress of the poor sort and of the Married Soldiers. The Great Want now seems firing. There is plenty of Flour thank God, but the Wood is So Scarce that the Bakers are not allowed enough to Bake as Much as formerly. The poor Women and children are round the Bakers Doors every Morning, in Vain Waiting with their money. Tho' they have Money they cant get Bread. It is hard upon those people. The Troops of Course Eat their full allowance of Bread. It is their familys who feel the hardships and are to be greatly pitied.

Sund 24. Westerly wind. Not any Ship able to go out. I have been exceedingly ill all Night, a most Violent pain in my Left Arm and ill in all Respects, did not stir out of my Bed Room all Day. A Red Flagg has been hoisted on board a Frigate at Algezira 2 Days. N.B. A Court Martial.

Mond 25. Easterly wind. All quiet in the Camp. Am a very little Easier. A Cow belonging to Capt Uniacke 58th pretty far advanced in Calf fell down from some part upon Wind Mill Hill, was either Dead or obliged to be instantly Kill'd, for which He Received 300 Dollars in Money and a Milch Goat Valued at 30 Dollars. This Beef was Sold at 7 Rs per lb. Dollar 38 pence. N.B. It is now said that Capt Uniacke had sold this Cow to the Milk Man some Days before this accident happened. If so the loss to the poor Man was very great and it does appear better on the Captn's Side. He really did receive the above Sum &c for the Cow but no doubt the Milk Man expected the Calf would live.

Tuesd 26. Easterly wind. Looks like Rain. Find that some of

Digitized by Google

26th September, 1780. the Ships got out last Night, viz., the Dutch Ship *Handalein* and the Brig belonging to Mr Anderson. It was the Ship with Mrs Gledstanes that sailed. I am rather better this Morning but not Well enough to go down stairs &c. The Colonel had a party of Gentlemen to play cards in evening. It is to be a sort of weekly meeting.

Wed 27. Easterly Wind. 2 more Ships got off last Night and there are still two remaining which I hear are expected to sail this Night. On board of one goes a Mr Young and Wife by whom I write to my Daughter Nicolls. Find my arm better, but very ill.

Thursd 28. Easterly Wind, but to our Disappointment these 2 Ships did not sail. It seems they can not go Unless they Receive Orders and it is to be feared they will now be too long Detain'd. *It* was one of the most favorable Nights, blowing very hard and Dark. We are all much Vex'd at this Delay.

Fry 29. Easterly wind. A Deserter came In this Morning, a Serjt of the Wolona Regt. He came upon his Hands and Knees from the Lines! He brings a Confirmation of the Enemy having taken our West India Convoy and that there are 59 Vessels now in Cadiz. The Men of War that was the Convoy are got away We hear. A Spainish Frigate came from the East, very much disabled, having Lost Her Bowsprit &c. N.B. I omitted to set down the Orders of Wed 27 "Biscuit will be delivered in Lieu of Soft Bread from Monday next the 2nd October till further Orders, to begin at the Boat House. Hospitals to have Soft Bread."

Saturd 30. Westerly wind. A Boat getting ready for Minorca. Much talk about this Deserter. He is by Birth a Strasburger, has been in Many Services, Speaks English, was four years in England carrying on a Sort of Trade. He is Suspected to have come In more as a Spy than any other Thing. He has the Dress of a Peasant on; says He sold his Regtl Sword and watch to purchase it. He is a very handsome clever man. The Gov^{r} has sent him out to the Southward and has order'd that a Noncommissioned officer should go everywhere with Him. This afternoon We had the Vexation to See a Ship taken Into Algezira which is believed by most Judges to be that one with Mrs Gledstanes on board! We had flatter'd ourselves she was got clear off. Suppose We shall hear more about this to Morrow. The Deserter also reports that the Enemy have a Work all Ready Fram'd; a Sort of Battery which They intend to bring through the Lines the first suitable Night. They have it seems been waiting for Dark Nights; and it is now such.

At the Close of this Month all Degrees of people begin to look Uncomfortably, and it is much to be feared the Unpleasantness of the times will rather increase than lessen.

Sunday Oct 1. Westerly wind. This Morning at Day Break it was discovered that the Enemy had been busily employed and had Erected

Digitized by Google

a Sort of Battery near to the Tower upon the Neutral Ground, considerably on this side their Lines and about 700 Yards from the Bayside Guard. At Day Break they also Set Fire to the Garden Hutts, Destroying the Wheel belonging to the Well. At the Same time they advanced and fix'd a Sort of Combustible in form of Hand Granade and other Inventions upon and standing against the Pallisading at our Inundation, amongst our Out Guards. As Soon as the Centinels observed this they began to Fire, but those at Forbes Guards seem'd to be alarm'd and came in to Landport. Those at the Head of Kings Lines were very alert and fir'd all their ammunition. N.B. Some of these Fire Works were inclosed in Skins and as big Round as a Man's Body. Others were Smaller and were with an Hook all Ready to hang upon the pallisading. The Large ones were set against the pales. Some were also done up in Tin Cases, Cover'd over with a kind of paint; to hold the Lighted Matches. Captain Martin was upon the Batterys; did not hear any thing of the Enemys Manœuvres till it was Day Light. It is every Bodys opinion that they will Fire as Soon as We begin with them. Therefore it is now more Resonable to be fearful than ever it was. The Work they Erected last Night is at present of no use to them, but it may be only by Way of Commencing; or to divert our attention, or to provoke, and draw on, our Fire. However it has put Us all in Motion, and most of the officers are going up the Mountain. Captn Loyd went up to Relieve Captn Martin at Guard Mounting. Col Green three times up the Rock this Day, went to the Govr at 2 oclock. Articles of War read this Day. I shall be better able to Speak more on this Subject very Soon as I am promised to have a full account of what the Enemy has done and where about this Battery is Erected. It is about 100 ft in length and pretty thick. The Bomb proof Under our Garden is nearly Completed. It is quite ready now for Use. In Consequence of what has happened We put a few Necessaries In lest the Enemy should attempt any thing this Night, as it is believed We shall throw a few shott at them. We therefore get ourselves pretty Well Guarded. About 8 this Evening Captn Loyd threw some Light Balls. He could not distinguish any Persons at the Work, or hear any Noise. We continued throwing those Balls till near 10, then Left off and again began at 2 in the morning. The Enemy did not return our Shott. We are now certain that is the Vessel with Mrs. Gledstanes on board and an other that went out the Same time she did. Mrs Gledstanes and her 5 children &c was plainly seen through several of our Glasses this morning as they were removing Them from the Ship. Every Body is concerned at it. She took a letter from our Govr desiring if she should be taken that the Spainiards would forward Her and family to Farro or Lisbon, informing Them she was a Field officer's Wife who was gone to England some months agoe upon account of His bad Health. We all hope such a letter will lead Admiral Barcelo to shew

1st October, 1780.

Digitized by Google

1st October, 1780. proper attentions to Her and that He will Send Her to Cadiz rather than back into this most Wretched Garrison. The Guards mount at 8 and the Gun Fire's at 8 in the Evening. We Seem to Understand that Conde D'Estaing is come or Daily expected over the Way and in the Camp, as the last Flag of Truce, one of the Spainish Genls *Aid de Camps*, told our Secty that He was expected upon a Visiting footing to the Encampment. He has been at Cadiz Some time; and as We hear, is to have his Flag on board a Spainish Man of War and is to act Under Don Luis de Cordova.

Mond 2. Westerly wind. All quiet from the Enemy. About 6 this Morning a very Large Suite of officers came down to the Spainish Lines, amounting to 40 with Guards &c. It is Supposed to be D'Estaing. The Party went to Fort St. Philip. This forenoon we had the Mortification to see 2 other Vessels taken into Algezira; *it* was the Dutch ship that has laid Here a long time the *Handilein* that should have gone out the Same Nt with Mrs Gledstanes; and one other Transport. This makes 4 that have been taken over there. N.B. Andersons Brig We hope and believe is got off Safe to Farro. There are Several English officers on board those ships, most of them Gentlemen who have been changing from out of the Regts in Gibr,—A Mr Gregory of 58 and a Lt Cook of 56th. At Noon this Day, as the Suite returned from the Lines to the Camp there was 17 Guns fir'd from Point Negro, which Seems to Confirm the opinion of D'Estaings being there. Our out Guards are Order'd to be particularly attentive. They are So; and fir'd Small Arms in the Course of last Night from Bay Side. The American Club Day—very Moderate indeed. Colonel Ross was upon the Grand Parade this Morning at Guard Mounting for the first time Since the Court Martial. He had his Sword on. Made Several Visits afterwards, call'd upon me in the forenoon; Looks Well but seems a little agitated and rather Grave.

Tuesd 3. Westerly wind. Very early this Morning the Enemy was observed to be Working at their New Battery. The Govr sent Word up to Fire upon them. They did So and a great many Shott and Some Shells were thrown. We dislodged some part of the Work but did not do any Essential Hurt. They keep a few Men and a Centinel there the whole time. The Garrison now seems in a Bustle and the following was in Orders this Day,—"In case of any Sudden Attack in any of the Posts the Officer Commanding there will make such Disposition for the Defence of his post as the nature of the Attack may seem to him to require." The Govr was up at Williss before Dinner, and as We hear pointed one of the Guns, which had the Good luck to hit their New Rais'd Work. N.B. If this is not true I will mention it in my Journal as a mistake.—N.B. A Mistake. At three oclock a parley came from the Enemy Relating to Sending In those soldiers wives and other Women that were taken in those Ships that are now over at Algezira. We also hear that Mrs Gledstanes is to come

Digitized by Google

which We are all very sorry for, and think it hard indeed upon her. 3rd October, 1780.
At 4 a Memorandum was put into the General Garrison Orderly Book as follows,—"As the Govr expects Count D'Estaing will Reconnoitre the Garrison in a Boat the Officers Commanding the different posts are not to Fire at Him except He comes too near, but in that case are to fire over Him." The 2nd of the Whist meetings at Judge Frazers. N.B. Several Persons who saw the Party Yesterday Seem to think it was not D'Estaing but Conde de O'Reilly who is Captain General of the Province of Andalucia. Time will let us know more of this matter.

Wed 4. Westerly wind. Major Burke went out with an answer to the Enemy's Parley of yesterday. He went on much further than Usual in order if possible to give a Glance at their new Work. The Guard which was there call'd out to him, making Signs not to advance, but He Seem'd not to hear. He was just able to give one Look at the Rear of the Work. It is totaly Unfitt for Service as yet. The Flag of Truce is to come In to Morrow. A Privateer Cutter was taken last Night in the Bay, coming from the West and carried into Algezira. A great Number of shott was fir'd on both sides. A Xebeque took her. A small Boat came late this Evening from Barbary; no kind of Supply; only 2 letters from Mr Logie to the Govr.

Thursd 5. Easterly wind. A Parley this Morning came In by which We find that Mrs Gledstanes and her family are to Remain at Algezira till an answer comes from Madrid. This pleases Us much more than if she was Sent In, and is no doubt in consequence of the letter which she carried from the Govr. The other Women are to come In today.

Fry 6. Westerly wind. All very quiet this Day. In the Course of last Night I was taken Violently ill, with a Dreadful pain in my Leg, attended with a Fever. Continued in Bed all Day, and at Night much Worse.

Saturd 7. Westerly wind. Worse than before, grew so bad that Doctor Baynes was obliged to Bleed me on Saturday Evening, not able to be taken out of bed. I was engaged for this Nt at Major Fauncourfs but sent the excuse. The Flag of Truce came In. We hear the Admiral Barcelo is exceedingly polite to Mrs Gledstanes. This Evening it Rained most amazingly hard; and at 4 the Sunday morning and on till 7, it was Violent. We hear D'Estaing is gone from the Camp to Cadiz.

Sund 8. Westerly wind. Raining hard indeed, but no harm done. Three Inches and half of Water fallen in the course of last Night and this Morning. It cleared up at 10 and was a very fine Day. I was rather Easier but could not be taken up. The pain all in one Leg, can not get any Rest or Sleep, very Low in spirits. What English officers were over at Algezira are gone with D'Estaing by sea to Cadiz.

Digitized by Google

9th October, 1780. *Mond* 9. Westerly wind. Find myself a little Easier; get up for the first time about one oclock. It Rain'd a little this afternoon. Ill at Night. Great complaints of the Dearness of every article; one calf killed which Sold for 10 Rials pr lb; and one Pig for a Dollar per lb.

Tuesd 10. Westerly wind. All Quiet this Day. Am a little Easier, get to my Work again. This Evening the Col Went to the 3rd Whist meeting at Col Craig's. He was *here* before He went. My Spirits exceedingly bad and not to be Wonder'd. Disappointed in many things, particularly Dr Baynes.

Wed 11. Easterly wind. Raining a little this Morning. We hear of a Minorca Boat coming In who Mentions a Vessel Seemingly one of a Dutch Convoy going to the Enemy from Malaga, being behind the Rock. Our Boats went out and We had the Satisfaction of bringing Her Safe In. She is Loaded with Many Useful Articles; says he is a Dane. The Master appears Sulky and Seems Uneasy at coming In. Some people doubt if We shall get the Fruit or Oil or indeed any thing from on board. She Certainly did not Mean to come In, only was Drove too near. Several Row Boats were after Her. The Weather very mild all Day.

Thursd 12. Easterly wind. Find myself exceedingly Low and ill and that it is absolutely Necessary to change my Room for the Air. I came out into Dressing Room on Crutches. A man of 56th Deserted from Signal House Guard. He got as far as the Devils Tower quite Naked. He was fir'd at from Williss with Grape Shott. He got behind the Tower. At last upon Seeing a Boat going Round he took Courage and ran across the Sand to the Nearest Centinel of the Enemy, who Received him, and got into the Lines in Safety. The Vessel which came yesterday is not Dutch We are now convinced, is loaded with Oranges, Lemons, Raisons and Figgs, which We hear is to be sold here. The Boat has brought Some Oil and Sugar, also some Cheese. It Rained a little This Day. There is not to be any more Parleys by Land on either Side for the future; all by Flag of Truce by Sea.

Fry 13. Easterly wind. Raining this Morning. Close Damp Weather. Affects every Body more or less. Of the Number of Complaining Persons I am the foremost as I am at this Instant so ill and so hurt in my Constitution that I can not Walk. Out again in my Dressing Room, very helpless, can not Stand but on Crutches.

Saturd 14. Easterly wind. Dull and Close. Still very helpless. The Lemons and Oranges are this Day sold to those who gave in their Names to the Q.M.G. In consequence we got a Double Chest of Lemons. They Seem very fresh and Good. It is said they will come Reasonable, tho' the True price is not known as yet. The other Articles are not to be Delivered till next week. We have got some of the Cheeses from Minorca and are in expectation of oil. This Day there is a Calf Selling. The Veal is 10 Rials. That indeed has been the price of late, but it exceeds all beleife almost; when I add that

Digitized by Google

10 Dollars was this Morning given for the Head and Feet ! the Pluck sold for 6 Dollars. The Butchers are begging any officer or Person who is in possession of Cows or Sheep to part with them ; and the price they offer is beyond all idea. 12 Guineas a Butcher offer'd our principle Servant Man for one of the Colonels Sheep, and £60 for one of the oxen in the Kings Works, both which, of course, Were Refused by the Man. 14th October, 1780.

Sund 15. Easterly wind. A very great Fogg early in Morning which clear'd up about Noon, and it turned out a very Close Warm Day. I try'd to go down to dinner but could not. Several Persons call'd. Col : at the Mount with the Gardeners. 2 Gun Boats belonging to the Enemy Rowing about in the Bay all Day. N.B. I am to get a Drawing of one of those Boats.

Mond 16. Easterly Wind. This Morning early one of our Batterys at Europa fir'd a few shot at the Enemys Gun Boats which were coming too close In. They afterwards fir'd at a Boat of ours ; on board of which was Lt Burleigh of the 39th Regt who has an appointment from our Gov^r as Commanding a Party of Marksmen to be Ready on Certain Duties. He was out this Day fishing. The Shot went over his Head and Struck against the Line Wall. He brought it into the Garrison. I had a Visit this Day from Genl Boyd—all very Well, very Sociable. Lt Holloway of the Corps of Engineers has been for some Days employ'd Laying a Large Boom at New Mole,—a Work of Labour and trouble. I got help'd down to dinner this Day.

Tuesd 17. Easterly Wind. Colonel at the Mount to Breakfast with the Gardeners. The Enemy again firing at our Garrison fishing Boats, particularly the Hake Boats. They are, and have been, very busy at a Work, just on the other Side of their own Lines, but of what kind is not quite Certain. They do not Seem to go on with their New Work on our side the Lines—that still remains in an Unfinish'd State—it is supposed to be intended for a Mortar Battery.

Wed 18. Easterly Wind. A Cold Uncomfortable Day. The Gun Boats out again, and Strive all they can to hinder our geting Fish,—however We still get some, tho' of course it will be attended by this Consequence—the fishermen will avail themselves of this New difficulty, and encrease the price of Fish, which is already exceeding Dear. N.B. The Salt fish is quite over—that is amongst the Troops. N.B. No Sorrow Shewn on that Occasion.

Thursd 19. Easterly Wind. A Boat arrived from Minorca. No live Stock. Some little quaintity of Wine and Sugar. More Gun Boats, which We fire at from the different Batterys and from our Ships. The following Orders given out this Day :—" Issues of Provisions for the next Month, commencing 23 October and ending 19th Novbr 80. The Stoppage of Beef will be paid for at the rate of 20 Quarts per pound—whereas by the agreement last Janry the price was settled at 12 Quarts ; and the Oatmeal at 24 Quarts per Gallon. Bread as Usual.

Digitized by Google

19th October, 1780. *Officers pr Month.* 6 pound of Beef; 4 pound of Pork; 4 pints of pease; 6 pints of Wheat, 3 pound of Flour, 2 pound of Raisons, 4 pints of Beans (in lieu of 12 pints of pease and 30 oz of Butter); 10 oz of Butter; 4 pints of Oatmeal; 4 lb of Beef, 8 pints of Oatmeal (to be paid for).

N.B. Colonel Green continues to Draw his allowance of Ten Rations.

Men pr. Week. 1½ lb of Beef; 1 lb of Pork; 1 pint of pease; 1 pint of Oatmeal; 2½ oz of Butter; 1½ pints of Wheat, ¾ lb of Flour, 1½ lb of Raisons, 1 pint of Beans, ¼ pint of Vinegar (in lieu of 3 pints of pease and 7½ oz of Butter); 1 lb of Beef, 2 pints of Oatmeal (to be paid for).

Hospitals pr week. 1½ lb of Beef; 1 lb of Pork; 3 pints of Oatmeal; 2½ oz of Butter; 1½ pints of Wheat, ¾ lb of Flour, ½ lb of Raisons, ½ lb of Rice, 1 pint of Beans, ½ pint of Vinegar (in lieu of 4 pints of pease and 7½ oz of Butter); and 1 lb of Beef (to be paid for).

Fry 20. Westerly Wind. Colonel Green went on board the Several Ships in the Mole and Harbour and Examined the Boom at New Mole. More Gun Boats. It is now known for Certain, the Enemy have put down a great Number of Anchors near where our Boats go fishing. Time will Show what They Mean by it. This Day remarkably Warm for the Season. Every Body wishing much for Rain—both on account of Peoples Health, and likewise for the Gardens—that being of very Essential Consequence just now. The Govr has given part of that Ground at Landport call'd the Govrs Meadow to Some of those poor men who Suffer'd by the Enemys Burning their Gardens and Hutts.

Saturd 21. Westerly Wind. A Boat is bringing Round from Catalaine Bay. She is coming to Us from Algiers; Loaded with Wine and Leather. Many People thought she would be put Under Quarantaine, but it was not So. N.B. The *Enterprize* Boat had been on Board before any of the Garrison Boats, and the Govr had Received Some Letters. Quarantaine could not therefore be so Well observ'd as that would have Subjected all *Parties* to share alike. This Evening a Number of very Large Ships appeard in Sight from the West—all Line of Battle. They appeard Under Russian Colours. Yet Many are of opinion They are French Ships, going most likely to Touloun. They went through the Gutt towards the East. There were 8 in all.

(*To be continued*).

Digitized by Google

MEMOIR.

COLONEL H. C. SEDDON, R.E. (Ret.).

COLONEL HENRY COOPER SEDDON obtained his commission in the Royal Engineers in 1856, and, after the usual course at the S.M.E., was attached to a company at Shorncliffe Camp for nearly two years, doing the ordinary engineering duties of the district, and latterly taking charge of the Hythe Division for Major Ewart, temporarily detached for duty in London.

From 1859 to 1864 he served in Tasmania, under Colonels Delves Broughton and F. R. Chesney, as Executive Officer in Charge of the Imperial Buildings, Lands and Military and Convict Stations, and he was also employed by the Colonial Government in erecting and maintaining the Coast Defences.

On his return home in 1864 he was employed as Executive Officer in Charge of Works at Guernsey and Alderney under Colonel Hadden, but having submitted to the Inspector-General of Fortifications a new system of iron armour for the defence of forts, was offered employment in London. His C.R.E. however did not wish him to be removed so soon, and he remained therefore for another year in Guernsey. He was transferred in 1865 to the command of the 38th Company at Chatham, under General Sir Lintorn Simmons, R.E., during which time he was also employed in reporting on armour-plate experiments at Shoeburyness, as well as in assisting Colonel Wray, Instructor in Construction, on engineering tours with the young officers under instruction.

From 1867 to 1873 he held the appointment of Assistant Instructor in Construction at the S.M.E., and, being the first officer appointed to instruct in measuring, estimating and builders' work, he had to draw up the whole course of instruction for the officers and N.C.O.'s of the Corps. In that capacity he also became well acquainted with all the details of the Chatham Dockyard Extension Works, besides twice a year visiting and reporting on the most important engineering works in progress in different parts of the country.

From 1873 to 1879 he was head of the Designing Branch for Barracks at the War Office, when, besides the ordinary work, £3,000,000 was expended on the Brigade Depôts under the Military

Digitized by Google

Forces Localization Act. He also planned out the new Knightsbridge Barracks, and the New Victoria Barracks, Portsmouth.

From 1879—1885, he was Instructor in Construction at the S.M.E., teaching the theory and practice of civil engineering construction. During this time he again constantly examined the Chatham Dockyard Extension Works, with the officers under instruction, as well as engineering works of all kinds, including the failure of the Tay Bridge, and the construction of the Forth Bridge which was then in course of erection. He was also employed by the Home Office to enquire into the Bradford chimney disaster in 1883, and subsequently into the safety of the Kingsland Bridge over the Severn at Shrewsbury.

During this time he edited the *R.E. Aide Memoire* in two volumes, and second and third editions of Colonel Wray's *Instruction in Construction* for the S.M.E. He also published *Builders' Work and the Building Trades*, a textbook largely used by students of building construction.

In March, 1885, he was appointed Superintending Engineer of Portsmouth Dockyard, but, as he was at that time engaged on a plan for moving bodily 50′ to one side, Carrington House (the work of Sir William Chambers and then opposite the Horse Guards) so as to open up the road towards the Embankment, the Inspector-General of Fortifications stipulated that, if carried out, his services were to be available for that purpose. But on a change of Government the scheme was dropped.

He retired from the Army 1st October, 1887, refusing the rank of Major-General on retirement. In September, 1890, he resigned the post of Superintending Engineer at Portsmouth.

Seddon was Assistant Examiner in Building Construction to Science and Art Department, South Kensington, from 1870—1875, and Examiner from 1876—1900, the last few years being under the Board of Education, as well as Examiner in Engineering Subjects for the Civil Service Commissioners.

After leaving Portsmouth Dockyard, he practised in London as architect and engineer from 1892—1900, when he acted as surveyor to the trustees of the Earl of Dysart's estates in Surrey, Lincolnshire and Leicestershire. Amongst some of his works he built the transforming stations and workshops as architect to the City of London Electric Lighting Company; designed and carried out the drainage and sewage works for the Ham District Council.

Seddon was gazetted 2nd Captain in 1866, Captain in 1872, Major in 1874, Lieutenant-Colonel in 1882, and Colonel in 1885. He died at London on the 8th December, 1911.

Digitized by Google

TRANSCRIPT.

HORIZONTAL ANTENNAE.

Translated by Major S. MILDRED, R.E., from *Armeeblatt*, Vienna, December, 1911, with the kind permission of the Chefredakteur Hauptmann Victor Hueber.

THE following article, which has been forwarded to us by the General Staff, War Office, is taken from the *Elektrischer Anzeiger*, No. 91 :—

The meeting of the German Physical Society, which took place towards the end of last month in the Physical Institute of Berlin University, was particularly attractive owing to the announcement of a lecture by Dr. F. Kiebitz on the subject of "Recent Experiments in Directed Radio-telegraphy with Earth Antennae." For some considerable time reports have appeared in the public Press of such experiments on the part of the Experimental Department of the State Telegraphs, which were conducted on a 13-acre piece of flat heathland near Belzig. It was reported that the results were astonishing; but particulars were withheld, as they had been promised to the Physical Society in the form of a lecture by Dr. Kiebitz, who superintended the experiments.

What the lecturer had to say about these experiments, which may be said to have recently reached a certain finality in results, will not fail to produce a far-reaching sensation. For it means an important step in the progress of wireless telegraphy, that great marvel of modern times. It means that in all probability, and in the not remote future, the aerial networks (antennae), supported by towers and masts, which up to the present have been used, can be replaced by horizontal antennae, where the station is situated on suitable level ground.

This change, by which a large saving in the cost of construction is promised, will make it possible to use much heavier currents with the attendant increased range of communication. For, in spite of the construction of huge towers, it has not up to the present been possible to make antennae, which would admit of the practical introduction of high-frequency machines and the exploitation of their enormous powers. This, however, will now be possible. Finally, an advantage of far-reaching importance will be found in the fact that by means of earth antennae we shall be in a position to direct electric waves within fairly narrow limits. This will presumably put a stop to, or at least reduce, the chaos of wireless messages in the air; a chaos which grows worse as the number of wireless stations increases.

It is well known that universal astonishment was expressed during the

Digitized by Google

progress of wireless telegraphy, at the fact that the curvature of the earth presented no obstacle to telegraphing between far distant stations. This experience led to the assumption (and this has been shown to be correct by experiment) that during the expansion of the waves the electric field is at right angles to the earth's surface.

As early as 1902 and 1904, Lecher had formed the opinion from the above-mentioned fact, that the propagation of waves was to be considered as the propagation of charges on the earth's surface, and that it should be possible to receive wireless signals by means of two suitably arranged earth connections instead of an aerial one. Dr. L. Zehnder gave expression to similar thoughts in the specification of his patent (Austrian Patent 26404) for telegraphing without continuous conducting wires by the use of earth-waves.

In each case there was the tendency to look upon the process of propagation from the point of view that Hertzian waves in the air are accompanied by corresponding wave motions in the earth. Lecher's theory could be further extended hereby, in so far that earth antennae behave like metallic insertions in a semi-conductor, and are capable of conducting waves of a certain frequency and also show powers of radiation.

In support of this theory Leimbach's observations have proved of value, viz.:—that it is possible to telegraph inside the earth with electric waves.

Such was the theoretical value given to the results of experience, when Dr. Kiebitz was commissioned by the Imperial Post Office to undertake experiments with earth antennae.

In November, 1910, he succeeded in telegraphing from Potsdam to Berlin using a generator giving an energy of 150 watts in the earth antenna.

The experiments, with the co-operation of Messrs. Hartenstein and A. Klage, were continued in the summer of this year near Belzig, using an energy of 1,000 watts in the antenna, and they have recently been concluded.

The station, which was erected on the flat heathland near Belzig, consisted of a wooden house, containing the transmitting and receiving apparatus, and a number of earth antennae. These were constructed as follows. Seven principal earth connections were made; one was situated in a central position near the house, one at a distance of 150 m. from the house in the direction of the experimental station at Schöneberg, and one also at a distance of 150 m. in the reverse direction; the other four were each laid at a distance of 120 m. from the house in directions directly north, south, west and east of it. The direction of Schöneberg was as nearly as possible south-west.

The earth connections were constructed as follows:—A hole was bored 4 m. in depth, where loose and damp sand was encountered and further digging found impossible. Into this hole a thin zinc plate of 25×200 c.m. was lowered and a lead of galvanized-iron wire of several strands was soldered to it. The hole was then filled in with coke up to about $2\frac{1}{4}$ m. and finally covered in with sand. Each principal earth was made up of a certain number of the zinc plates described above. Thus, the

Digitized by Google

three first mentioned (one at the house and two at 150 m. distance) each had seven plates, whilst the other four had four each. Each group of plates was made into one earth by being interconnected with buried bare iron wire. All these earths were worked in pairs, with the exception of the one in the centre. The spark-gap was situated in the house, and it was connected to the earths by bare bronze wires, 1·5 m.m. in diameter, carried on 1 m. high wooden supports with porcelain insulators. In the neighbourhood of the house, and where a road crossed the path of the conductors, the bare wire was replaced by 1·5 m.m. heavily insulated copper wire laid underground. Leyden jars were interposed between the outer ends of the connecting mains and the earths. The jars were placed in wooden cases and packed with paraffin wax. Sometimes the earths were not used, but the conductors in the six mentioned directions were left with free ends. In this way there were six horizontal antennae, four of which were 120 m. long and in the directions N.S.E. and W. and two were 150 m. long in the directions S.W. and N.E. Or three antennae could be formed of 240 m., 270 m., and 300 m., respectively. With this apparatus experiments at receiving were first made.

The station at Schöneberg was heard without trouble in the antennae situated in its direction, even when very little power was used at Schöneberg. Using the pairs of antennae N.S. or E.W., N.W. or E.S., it was not so audible, whilst with the pairs N.E. and S.W., which are at right angles to the direction of Schöneberg, it was not heard at all. The best results were obtained when a copper band, 2 c.m. in width was used for the main connections (120 m. and 150 m. in length respectively).

The wireless telegraph station at Swinemünde (distance 230 k.m.) was also heard in the long antennae of 150 m. and 300 m. Its direction makes an angle of 23° with that of Schöneberg. The best signals were obtained when a wave-length of 1,500 m. was used.

The great station at Norddeich was heard with great distinctness on all the antennae. All that it was necessary to do in order to hear Norddeich, was to throw on the ground an insulated wire 200 m. in length pointing E. and W. and to interpose a receiving apparatus in the middle.

Time signals were regularly picked up from the Eiffel Tower, and sometimes telegrams on the antennae in the direction of Schöneberg. Wave-lengths of 2,000 m. and slow sparks were used. The sound intensity, which could be measured accurately, had similar values to that of Norddeich.

The Admiralty station in London was easily heard *both by day and by night* on the pair of antennae E.W. The wave-lengths were measured as being 3,400 m. As Whitehall is occasionally heard at Schöneberg on an aerial conductor 40 m. in height, but *not by day*, it follows that an earth antenna of a length of 240 m. is superior to an aerial antenna of a height of 40 m. The Marconi station at Poldhu could also be heard on the pair E.W.

In addition to the stations mentioned, which have regular times for transmitting, many others were also heard, in the first place the experimental station at Berlin. During the Imperial manœuvres signals were picked up by day and night from several military stations. Of the larger

Digitized by Google

stations, Pola could repeatedly be recognized by its method of transmission.

Atmospheric disturbances were nearly always to be detected during the thunderstorm season, very often on July nights with a perfectly clear sky. For hours occasional flickers of light could be seen on the southern horizon, evidence of distant storms, which were simultaneously signalled in the receivers. These disturbances were minimized, without weakening telegraphic signals, if the two outward earths were connected by one of the conductors lying parallel to them on the earth.

An interesting experiment was made to find out if it was possible to pick up signals from the transatlantic Marconi stations at Clifden, in Ireland, and Glace Bay, in Canada, which send out waves 6,000 m. in length.

An insulated line of wire 1,270 m. long, was laid out in the direction of Glace Bay. The first portion of this, about 500 m., consisted of bare wire carried on insulated supports, one m. in height, and ran over heath and fields. The second portion, which ran through wood and thicket, consisted of insulated wire hung on branches within reach. Widely extended wire fences, which protected young plantations, served as earths. As was to be expected, the result was satisfactory. From 15th to 22nd September the Marconi stations could be heard early in the day and in the evenings from 5 to 8 p.m. in spite of the fact that during the whole time air and earth electric disturbances were particularly strong.

They made themselves noticeable by a bubbling in the receiver. Between 6 and 7 o'clock in the morning signals from Glace Bay were repeatedly heard for a few minutes. They were recognized by the syntony and the high whizzing sound.

The signals were loud enough; the test could have been taken down, if the atmospheric disturbances had not been so powerful. The wave-lengths from Clifden were found to be 5,600—5,800 m.; those from Glace Bay 5,800—6,000 m.

A particularly interesting task of Dr. Kiebitz and his assistants was the verification of direction by means of experiments.

With the aid of the crossed antennae, N.S. and E.W., the direction of several distant stations was determined according to the principles of Bellini and Tosi. The radiogoniometer was constructed by the experimental department.

Direction could be determined with certainty within 3° after establishing the fact that the earth within a radius of 25 k.m. did not offer any impediment to the waves.

Curiously enough there was a constant discrepancy of 8° E. between the direction of Schöneberg, as fixed after repeated trials, and its geographical direction. Schöneberg was using a wave-length of 1,400 m. Similarly there was a discrepancy in the case of Norddeich, which varied on different days between *nil* and 7° S. The reasons for this must have some connection with the uneven formation of the earth's surface and weather conditions; in the case of Schöneberg it may be due to the influence of the great Havel lakes, which may cause a change of direction of the waves. The observed bearings of the Eiffel Tower and Poldhu

Digitized by Google

coincided with their geographical directions. Nevertheless the accuracy of the observations were not to be relied on, probably because the waves become diffused on their long journey.

Finally experiments were made at Belzig in transmission. A 2-k.w. alternating current dynamo, driven by a petrol engine, was used as a generator with a periodicity of 500—700. The machine current was stepped up and then used to supply the oscillatory circuit with quenched spark. The antenna circuits were arranged in the same way as for receiving and in close magnetic coupling with the primary circuit. The experiments were most successful in communicating with Schöneberg; it was also possible to telegraph to Swinemünde with the same apparatus. After overcoming a few difficulties, Norddeich was communicated with, using the 1,270 m. long antenna and a wave-length of 3,500 m. Although this antenna was insufficiently insulated for transmission purposes, and in the woods crackling discharges to the rain-soaked branches took place, Norddeich picked up signals, although rather feeble ones. On this occasion the most important discovery was made that Schöneberg could not pick up the signals although its distance from Belzig is far less than that of Norddeich. The reason for this is to be found in the powers of direction of horizontal antennae. In this case the antenna that was used pointed to within 8° of the direction of Norddeich, whereas an angle of 122° was formed with the direction of Schöneberg. Herein lies the important and principal result of the Belzig experiments, the establishment of a valuable advantage of horizontal over vertical antennae.

Small stations on ships or in towns, which work with low power and short wave-lengths will, owing to structural considerations, still even in the future use vertical atennae; but for large stations horizontal antennae will be preferred owing to the enormous saving in the cost of their construction. In addition, the latter require less current and a lower pressure to produce the same effect. The energy in the antennae at Belzig was so small, that sparks of only a few centimeters in length could be drawn from them.

Horizontal antennae have a much higher capacity than vertical antennae. It will consequently be possible to use the strongest currents with them and probably the results obtained with the aerials now in general use will be surpassed. If their directive capabilities and their comparatively slight susceptibility to atmospheric disturbances are borne in mind, it would appear that there is a great future in store for the horizontal antennae.

Footnote to Col. 2, Page 6, of Original.

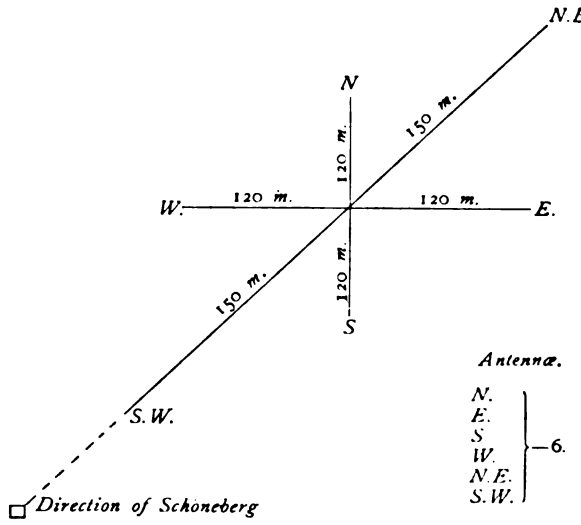
Dr. Zehnder writes in the *Elektrotechnischen Zeitschrift*, No. 44, in a treatise: "Does wireless telegraphy depend upon the radiation of Hertzian waves in the earth," referring to Dr. Kiebitz's lecture:—

"It affords me great pleasure and satisfaction to know that the lecturer, who formerly supported the view that the propagation of electric waves takes place essentially in the air and who accordingly worked with high aerials, is now working with my system of antennae, which he became acquainted with through the specification of my patent."

Digitized by Google

NOTE BY TRANSLATOR.

The arrangement of works apparently was as in this diagram :—



Thus there are 6 antennae as stated: It is also stated that "All the earths (except the centre one) were used in pairs, which presumably means that 15 combinations were used; but this is not borne out by the statement that there were 3 antennae of 240, 270, 300 metres respectively. The pairs mentioned as having been used are:—

N.S.—E.W.—N.W.—E.S.—N.E.—S.W.—N E.—S.W.

Digitized by Google

NOTICE OF MAGAZINE.

RIVISTA DI ARTIGLIERIA E GENIO.

November, 1911.

FRENCH MILITARY STATIONS FOR WIRELESS TELEGRAPHY IN MOROCCO.—The following information on the wireless telegraphy of the French Army during the recent military operations in Morocco, is taken from the *Lumière Électrique* of the 1st of July, 1910.

At the commencement of the campaign one fixed station and two movable ones were despatched to Oran for transfer to Taourirt.

The fixed station, destined to remain at Taourirt, had two artillery observation ladders of the Durand type—but with their height increased from 23 m. to 30 m.—with an additional mast at the upper extremity. This station gave a musical spark with alternator and resonator of the power of 5 k.w., and communicated a wave of 1,200 m. in length with Oran, Tangiers, Casablanca, Marseilles, etc.

The two movable stations were mounted on light two-wheeled carriages, each station having three carriages which carried respectively (1) the motor, (2) the apparatus for transmission and (3) the receiving apparatus.

Each station was served by five men and a head station sergeant. Fixing and starting the apparatus did not occupy more than 25 minutes. The electrical power was 1,200 watts, capable of corresponding by waves of 400 m. in length, over a region of from 100 to 150 miles.

These two movable offices had to collect and transmit the various reports of the troops to the fixed station at Taourirt, and, when necessary, to other stations in Morocco.

In addition to the above, the French engineers had sent to Casablanca one fixed and four movable offices, which, together with two old stations that existed in Morocco of a rather antiquated pattern, made up the number to one fixed station and six movable offices in the Casablanca district.

A fixed station was transported to Fez, and was similar to that at Taourirt, with the exception that there were four ladder observatories instead of two; the four movable offices were of different types; the *personnel* was similar to that at Taourirt, and the carriages were either of the old pattern of artillery wagons, two-wheeled, or colonial steel carriages of the Lefèvre type. One of these movable stations was of a special type. It was very light, and the material was all carried in one carriage which contained besides the motor, the apparatus for transmission and receiving, and the accessories.

Digitized by Google

The motor of this station was 1 horse-power, and was coupled to an electrical generator with musical spark of the Béthenod system—which supplies an electrical power of 300 watts. The whole weight was not more than 41 k.g. and the distance of transmission over sea was 300 k.m. The weight complete with carriage did not exceed 250 k.g.

The military network of all the above-mentioned stations was completed by a civil network, of which the principal stations were at Casablanca and Taourirt. These last being of an antiquated pattern, were more fitted for military engineering work at the commencement of the Morocco campaign of 1908, than later on. The satisfactory transmission of correspondence was always a difficult question, both because the power at these stations was insufficient to deal with the large quantity received, and also because the instruments were disturbed by the stations at Gibraltar and Spain.

AUSTRO-HUNGARY.—*Allowances for Aviation Officers.*—The *Revue Militaire des Armées Étrangères* for October announces that in addition to the allowance of three crowns awarded to aviation officers for every quarter of an hour of flight, the Austrian War Minister has decided to assign to the officers who have acquired the certificate of pilot :—

(*a*). A sum of 1,000 crowns.
(*b*). An allowance of 600 crowns for clothing and equipment.
(*c*). A monthly allowance of 15 crowns for the maintenance of the same equipment. This sum is only allowed during the time the officers are employed on aviation and carry out flights effectively.

Those pilot officers who have obtained the title of Field Pilot (Feld-Piloten) and those who are distinguished in exploration service, quickness of eyesight and precision in their information, receive an additional allowance of 2,000 crowns.

E. T. THACKERAY.

Digitized by Google

RECENT PUBLICATIONS OF MILITARY INTEREST.

REVIEWS OF BOOKS.

[Reprinted from *The Army Review* by permission of the Controller of His Majesty's Stationery Office.]

o o o o

FORTIFICATION AND MILITARY ENGINEERING.

BATTERY SIEGE-WORKS. Official manual. 67 pp. with numerous plates. 8vo. St. Petersburg, 1908. 3s. 6d.

This book is one of the special manuals for the training of Russian engineer troops, and it describes the various types of field works and platforms used for siege and fortress guns. The time-worn method of laying out these works by night is still employed; a simple form of rope framework is utilized to mark out rapidly the dimensions of gun platforms on the ground. One non-commissioned officer and four sappers constitute the engineer party allotted to supervise the infantry working party numbering from 75 to 90 men for each gun. It is laid down that 5 to 10 minutes' rest shall be allowed after every period of 20 minutes' work. A special chapter is devoted to the siting of batteries.

RUSSIAN REGULATION OF THE 13TH NOVEMBER, 1910, ON FIELD FORTIFICATION FOR OFFICERS OF ALL ARMS. (Règlement Russe du 13 Novembre, 1910, sur la fortification de campagne pour les officiers de toutes les armes). Translated from the Russian by Chef de Bataillon Painvin. 91 pages with 61 plates. 8vo. Paris, 1911. Lavauzelle. 3s. 6d.

This work is a very full *précis* of the Russian official manual "Instruction in Military Engineering for Officers of all Arms, 1910," which was reviewed in *The Army Review*, Vol. I., pp. 423—424. The plates are reproduced from the original Russian manual, but the dimensions on them have been converted to the metric system.

HISTORY.

THE FRANCO-RUSSIAN WAR OF 1812. Vol. VII. (*La Guerre Nationale de* 1812). Published by the Scientific Committee of the Russian General Staff, and translated into French by Capt. Cazalas under the direction of the Historical Section of the French General Staff. 415 pp., with an index. 8vo. Paris, 1911. Lavauzelle. 16s. 8d.

This volume, which is the seventh of the series, deals with the preparations for the war of 1812. The book is divided into three parts: the first containing correspondence between Russian Ministers or representatives and the Minister of War in December, 1811; the second

Digitized by Google

consisting of miscellaneous and undated documents which have been omitted from previous volumes; and the third being the correspondence of General Barclay de Tolly himself. The documents in each part are numbered consecutively, and are unconnected by any narrative; they have, however, been classified in the preface under thirteen headings, viz., reconnaissances of the western frontier and its defences, foreign fortresses, maps, supplies, intelligence from foreign countries, intelligence from Bielstock and Poland, secret agents, strangers entering Russia, plans for operations, internal administration, and inventions.

This classification and the addition of an index in three parts—(1) personal; (2) army units; (3) geographical—greatly facilitate reference.

The despatches in the first part are full of warnings of the inconvenience of war, and contain information which must have been of the utmost value to the Russian Intelligence Department. In this respect the most interesting are those of Colonel Tchernychev, an Aide-de-Camp to the Emperor who was stationed at Paris. In his despatch No. 18 we are afforded an insight into his methods. He has obtained, by means of paid agents in the French War Ministry, the march tables of the troops who are concentrating in Germany towards the Russian frontier, as well as the quarterly distribution states of all the French troops throughout the Empire. The disappearance of these pamphlets and their re-appearance in Russia has come to the ears of the vigilant Minister of Police; Napoleon utters threats of vengeance, the guilty officials are trembling in their shoes, and the watch kept on Tchernychev is redoubled; nevertheless he continues at his work, and his despatch of the 31st December, in which he asks to be relieved, contains information no less detailed than his preceding ones. Important intelligence was also supplied by Count Lieven at Berlin; his report of the 16th December that six months' supplies for 30,000 men were being assembled at Danzig should have left the Russian War Minister in little doubt as to the inconvenience of invasion. The movements of the Austrian troops towards Galicia and the probable attitude of Austria in case of a war between Russia and France are the subject of several despatches from Baron Tuyll at Vienna. One of these contains an interesting appendix in the form of some intercepted correspondence from the theatre of war in Spain, illustrating the extent to which Napoleon was hampered by Massena's failure to expel the English. The papers contain, among other matters, the form of proclamation in which Joseph was to announce his abdication, as a preliminary to the incorporation of Spain in the Empire, together with the reply which was to be made by the Council of State, and Napoleon's address to the Spanish people on taking over their country.

Among the miscellaneous and undated documents special interest attaches to a report (No. 11) on the military situation in the Duchy of Warsaw; to a letter from General Barclay de Tolly (No. 15) on the military geography of the probable theatre of war, followed by an "appreciation of the situation" (No. 16) by the same writer, for the perusal of the Emperor; and to a very full Memorandum on the defence of the Russian Empire (No. 20). The third part of the book contains some curious letters referring to secret agents, and deserters crossing the Russian frontier.

Students of history will be grateful to Capt. Cazalas and the French Historical Section for placing the sources of so much valuable information within their reach.

IMPERIAL DEFENCE.

CANADA AND CANADIAN DEFENCE. By Major-General C. W. Robinson, C.B. 186 pp. and maps. 8vo. London, 1910. Hugh Rees. 6s. net.

In the preface to this book General Robinson points out that, though many of the questions with which the Imperial Defence Conference of 1909 dealt have been widely and closely examined, yet there is still much in connection with the defence of the Dominion of Canada which requires to be more completely understood by British subjects generally.

It is accordingly with the two-fold object of teaching his countrymen something of the geography of Canada and of its defensive needs that General Robinson has written this book.

In Chapter I, the author points out the importance of considering national defence as a whole. He then draws attention to the part which Canada is likely to play in the future development of the Empire, and the consequent importance of ensuring its integrity. Now, at the Conference of 1909 it was laid down as one of the principles which formed the basis of the defence organization of the Empire, that it was the duty of each self-governing nation to

Digitized by Google

provide, as far as possible, for its own security. The most effective way in which to deal with this question is, therefore, in the author's opinion—a view with which most people will be inclined to agree—first to examine into the character of the frontier concerned; next to study the most recent attempt which has been made to capture the country itself; and, finally, to consider the changes which have taken place since that date, and how far the experiences of the past can be usefully applied to the present.

Chapter 2 deals with the character of the boundary line of Canada, the outstanding feature of which is the extent of her inland water frontier. At the same time it is pointed out that for many hundreds of miles her southern frontier is a purely arbitrary one, while even the water frontier is, at some seasons and in certain places, no very serious obstacle to invasion.

The deduction which is to be drawn from these conditions is, therefore, that adequate naval power working in the closest co-operation with a sufficient land force is essential to her security.

The three following chapters deal with the campaigns of 1812—1814 in considerable detail, and are well worth careful study. The effect which control of the lakes exercised on the land operations is fully brought out, while at the same time the necessity of adequate land forces to take advantage of the naval successes becomes apparent.

In the author's opinion, the teaching of this war is that with reasonably adequate, well-equipped, and well-commanded naval and military defensive forces, Canada need not be overrun, and that, in the words of the Duke of Wellington, a naval superiority on the lakes is a *sine quâ non* of success in war on the frontier of Canada, even if the object should be only defensive.

Chapter 6 deals with the changes affecting defence since 1814; amongst these are to be noted some alterations in the boundary line, the introduction of steam and electricity, the construction of numerous canals and of an extensive railway system, and, as important as any, the convention known as the "Rush-Bagot Convention," by which the number and size of the armed vessels to be maintained on the lakes is strictly limited.

In Chapter 7, General Robinson briefly recapitulates the whole question, and sums up what the previous chapters appear to indicate as requisite for the maintenance of Canadian independence. The conclusion at which he arrives is that an efficient Canadian navy, together with a mobile land force, are essential to its safety.

Appendices contain an extract from the "Chicago Tribune" of January 30th, 1898, which deals with the question of the defence of Chicago; another extract on the subject of Lake Champlain, some details of the harbours and ports of Canada, and a table showing the duties of a local headquarters' section of the Imperial General Staff.

There are also three useful maps included in the book, which is a serious and valuable contribution to the literature of Imperial defence.

MEDICAL.

TROPICAL HYGIENE FOR ANGLO-INDIANS AND INDIANS. By the Hon. Surgeon-General C. P. Lukis, M.D., F.R.C.S., C.S.I., Director-General of the Indian Medical Service, and Major R. J. Blackham, D.P.H., R.A.M.C. 164 pp., with 32 illustrations. 8vo. London, 1911. Thacker. 4s. 6d.

In the preface the authors point out that the need for instruction in sanitation is greater in India than at home. The St. John Ambulance Association has now arranged a special curriculum adapted to the sanitary needs of India, but up to the present there has been no manual to meet the requirements of Anglo-Indians and Indians who wish to obtain the Senior Certificate in Home Hygiene granted by the Association in India.

This manual has been compiled to supply this want. An elementary primer for the Junior course is also in preparation.

The various problems of sanitation as met with in India are clearly described in simple language which can be easily understood by any one. The work should be of the greatest assistance to Europeans residing in India, as also to educated natives of India who wish to lead a healthy life and avoid contracting diseases formerly looked on as due to climate and therefore inevitable, but which in the light of our present knowledge we know to be preventable by the exercise of a little care.

Digitized by Google

SMALL ARMS.

THE SMALL ARMS AND AMMUNITION IN USE IN MODERN ARMIES. (Les Armes à feu portatives des armées actuelles et leurs Munitions). By Commandant Bornecque. 159 pp. 8vo. Paris, 1911. Chapelot. 3 vols. 9s.

This volume constitutes the third part of a series, Parts I. and II. having appeared in 1904 and 1905 respectively.

After a short survey of the development of small arms, the author discusses in detail the armament of 22 of the chief military Powers. Special chapters are devoted to automatic rifles, the instruction of the soldier in the use of the rifle, and the replacement of ammunition. The book concludes with comparative tables of (1) rifles, (2) carbines, and (3) pistols, in use in various armies.

As regards the future development of the rifle, Commandant Bornecque concludes that the question of a change in design is not yet ripe for decision, and that the Great Powers are, consequently, endeavouring to improve the ballistics of the existing designs by alterations in the powder and, more especially, in the form of the bullet. From a comparative table of the German and French bullets (page 62) it appears that the German "S" pattern gives the best results up to 800 metres (880 yards), but that at longer ranges the advantage is with the heavier "D" bullet of the French rifle.

The automatic rifle is still, in the author's opinion, in the experimental stage, and experts are by no means agreed as to the direction in which the rifle of the future is to develop. In this connection he quotes with approval the conditions laid down by the French War Ministry for a new infantry rifle (page 90), and the somewhat similar conditions (page 31) published in 1909 by a committee of the British War Office. In the case of France the difficulties in the way of a re-armament (which he estimates would involve the provision of 3,500,000 rifles and an outlay of 24 millions sterling) are so great that no premature steps are likely to be taken in this direction. Automatic pistols have reached a more advanced stage, and are in a fair way to replace the revolver as a weapon for short ranges.

As regards ammunition supply, Commandant Bornecque considers that troops going into action will require a supply of 500 rounds per man, and that if automatic rifles are ever adopted this number will require to be doubled.

STRATEGY AND TACTICS.

THE EVOLUTION OF THE ART OF WAR. (Les Transformations de la Guerre) By Major J. Colin. 310 pp. 8vo. Paris, 1911. Ernest Flammarion. 3s.

This is a book of great merit, and should be read by all officers interested in their profession. It shows sound learning, practical common-sense, considerable originality, and, what is somewhat rare in military writers, moderation, for the author, who is at the French Staff College, does not often push his conclusions to extremes.

The book is divided into three parts, entitled respectively "Le Combat," "La Bataille," and "Les Opérations," and under each heading the author studies the leading characteristics of (*a*) wars prior to the French Revolution, (*b*) the campaigns of Napoleon, (*c*) the 1870 and other wars of the 19th century, (*d*) wars of the 20th century, and concludes by attempting to show what will be the principles and methods of the future war of masses.

In his study of "Le Combat," Major Colin shows how, even in the classical period, a purely frontal attack never led any decisive result, which was only obtained by the manœuvring power of light troops c valry and a flank attack. With the introduction of firearms infantry tended to become the principal arm, and shock action was impossible without superiority of fire. Napoleon, especially, laid stress on the importance of fire, and often used his artillery to break the centre of the enemy's line. The wars of 1866 and 1870 taught the same lessons, but also proved that lines of skirmishers could carry out the assault, and that closed columns, which used to follow the firing line, were no longer necessary. The difficulties

Digitized by Google

of a frontal attack became more pronounced, and consequently enveloping movements were alone capable of obtaining victory.

In his forecast of the future fight, the author warns his readers that moral qualities are, after all, the basis of success, and, like several other modern French writers, he discusses the psychology of fear.

In the chapters on the "Battle," Major Colin repeats his remarks on the importance of an enveloping attack and turning movement, and points out that the latter were only possible when armies were capable of manœuvring. But towards the end of the 18th century, some generals, Moreau for example, in their anxiety to turn the enemy, spread out their forces in an extravagant manner. On the other hand, Napoleon, while marching on a broad front, could, and always did, concentrate his forces for the battle. His aim was generally to employ the turning movement as a means of forcing the enemy to use up his troops, and then to gain the victory by a decisive attack of reserves which the Emperor had carefully guarded.

It may surprise some readers to learn that, in the author's opinion, Moltke and his disciples preferred an enveloping attack to a bold turning movement. The Japanese at Mukden, on the contrary, made use of the latter method.

The battle of the future will probably show that an enveloping attack or turning movement is the surest method of gaining victory, and cavalry will be the most efficient arm for such movements and for a vigorous pursuit, but it must be a cavalry trained to use the rifle as well as the sword. It will be possible to hold an enemy in front with comparatively few troops, and railways may be utilized for unexpected concentrations. The two opposing armies will, in all probability, be both imbued with the doctrine of the offensive, and victory will remain with the commander who knows how to strike with the greater celerity and resolution.

That section of the book dealing with "Les Opérations" is perhaps the most interesting, for the greater part of it is devoted to a really masterly analysis of the Napoleonic system. In fact, this portion would alone entitle the book to a place on the shelf of every military library. Examples taken from the various campaigns of the Emperor show how he stood supreme in the art of so arranging the marches of large armies as to be always ready for any emergency. It may be also remarked that Major Colin on page 245, as a result of a study of Napoleon's methods, throws over the doctrine of the strategical advanced guard.

The concluding chapters of this section are remarkable for a just and generous estimate of Moltke, and for an equally just criticism of the evils of a passive offensive, by which the author means an attack founded on no proper plan or understanding of the situation, and solely inspired by a blind adherence to a system.

A Second Series of Tactical Schemes with Solutions. (Deuxième Série de Travaux tactiques: thèmes et solutions). 370 pages. 8vo. Paris, 1911. Chapelot. 4s. 2d.

This book is a collection of tactical problems which appeared in the *Journal des Sciences Militaires* between October, 1909, and July, 1911. The exercises, which are 18 in number, form a connected series based on a "General Idea" framed by General Bonnal; each scheme consists of a "Special Idea" and of four or five problems, the solutions to which are given at the end of the scheme, followed, in some cases, by a short narrative, which sustains the interest and serves as an introduction to the "Special Idea" of the next scheme. The solutions and narratives are illustrated by numerous maps, and, in one case, by a panorama sketch of the ground.

The "General Idea" is based on the situation of the French and German forces on the 26th August, 1870. The 1st and 2nd Armies of the "Eastern" nation have blockaded the 1st "Western" Army in the fortress of Metz; the 3rd "Eastern" Army is advancing south of Verdun in the direction of Paris; a 2nd "Western" Army, consisting of five Army Corps, has been concentrated near Rheims with orders to relieve Metz, or, if this should not prove feasible, to retire on Paris, delaying the invaders as much as possible. The positions of the various Corps of the 2nd Western Army at the outset of operations, and of the enemy's cavalry, so far as it is known, are shown graphically on a map at a scale of about 8 miles to the inch.

The general course of the operations are, briefly, as follows:—Soon after the 2nd Western Army has commenced moving eastwards, its commander becomes aware that the 3rd Eastern

Digitized by Google

Army, which is opposed to him, has discovered his intention and is changing direction northwards, so as to envelop his left flank should he persist in his advance. He accordingly resolves to retire on Paris, but decides to cover this movement by first dealing a crushing blow towards the south at a detached portion of the enemy's left wing, which is separated by the Argonnes from the main body of the Eastern Army. The 5th Corps, which has been acting as general advanced guard to the Western Army, is charged with the delicate duties of masking the change of direction towards the south, and leading the enemy to believe that the advance eastward is being continued; in carrying out the above tasks, this Army Corps becomes engaged with superior forces of the enemy and has then to break off the action and fall back fighting, without, however, becoming committed to a decisive battle. Meanwhile the main portion of the 2nd Western Army accomplishes its purpose, and attacks the detached wing of the Eastern Army on the Yevre, south of St. Menehould, enveloping its left flank and driving it northwards. After pursuing for a short distance, the Western Army commences its retirement on Paris *viâ* Chalons and Rheims. The whole period covered by the narrative is from the 25th to the 29th August.

The schemes are intended not only for candidates for the Ecole Supérieure de Guerre, but for officers of all arms who desire practice in staff work and the solution of tactical problems. It may, however, be said at once that the book presumes professional knowledge of a high degree on the part of the reader. It is true that many of the schemes, notably No. 11, include the operations of small detachments, but for the most part they are concerned with questions of high leadership. In the great majority of cases the tactical orders or dispositions required are those of the Army Corps or Cavalry Corps commanders, in circumstances which are sometimes of more than ordinary difficulty—as for instance that of the 5th Corps cited above—while the staff work includes such tasks as the dispositions of an Army Corps in billets or the arrangements for filling up the supplies of an Army Corps at the end of a day's march.

In spite of the magnitude of the forces dealt with, the "Travaux Tactiques" are in many ways suited for the study of officers in this country, provided that the readers are able to distinguish any points in which the solutions offered differ in principle from the teaching of our own training manuals. It will be found advisable, before commencing the study of the book, to draw up an "order of battle" for an Army Corps and a division of the French Army, and to obtain data for the road spaces of units larger than a battalion.

The schemes certainly succeed in the object, which is set forth in the preface, of creating situations which shall teach officers to think on definite lines. Among the most interesting solutions are the arrangements made by the commander of the 5th Corps (page 58) for misleading the enemy as to the direction taken by the 2nd Western Army; the dispositions of the Cavalry Corps (page 229) with a view to performing the quadruple duties of gaining information, covering the right flank of the Army, concealing the movement of a Corps which is coming up as a reserve in rear of this flank, and, eventually, co-operating in the expected battle; and finally the execution of the attack by the 12th and 13th Corps (page 530) against the enemy's left flank on the Yevre.

THE MARCHING OF ARMIES. (Les Grandes Marches d'Armées). By General H. Bonnal. 65 pp. 8vo. Paris, 1911. Chapelot. 1s. 2d.

The appearance in the *Revue d'Histoire*, during 1911, of a series of articles on the "Marching of Napoleon's Armies" has induced General Bonnal to return to the discussion of a theme which he first urged on the attention of the French Army as early as 1888.

The science of moving large bodies of men over the maximum distance in the minimum time may be said to have originated with Napoleon, who brought it to a standard of excellence to which it has never since attained. Indeed, it appears to have received little attention from military students during the fifty years following on Waterloo, and to have been practically rescued from oblivion by Moltke after the close of the Austro-Prussian War in 1866. The march dispositions of the Germans in 1870 have many points of resemblance with those of Napoleon's Army in 1806, though in the opinion of General Bonnal, they cannot bear comparison with their model.

In the words of the late General Maillard, one frequently hears it said that the maximum day's march for an Army Corps is 15 miles in seven hours; but this estimate, he points out, is

Digitized by Google

based on the assumption that the whole Corps is concentrated at the beginning and end of the day's march, and that, consequently, if the head of the column marches off at 5 a.m., the rear unit cannot start till six hours later, and has therefore only seven hours available for marching (*i.e.*, till 6 p.m.).

If, however, the Army Corps is not intended to concentrate at the end of the day there is no reason why the head of the column should not continue its march, and if the Corps is billeted each night in a depth corresponding to the length of the column, marches of 12 hours may then be performed for several days in succession.

The disposition in depth at the end of the day's march also possesses obvious advantages from the point of view of accommodation and utilization of local sources; in this connection General Bonnal contrasts the situation of the Army of Chalons (14th to 26th August, 1870), whose Corps concentrated every night, with that of the German IIIrd Army which adopted the Napoleonic system and, while performing longer marches, was better off for supplies.

As, however, an Army Corps marching in this way must eventually close up in order that it may be concentrated for battle, it is advisable that the rear of the column should perform somewhat longer marches than the head, so that the process of closing up should be accomplished as gradually as possible.

The best material for the study of this aspect of the question is to be found in the history of Napoleon's Campaign in Germany in 1806. For example, at the close of the day's march on the 7th October, 1806, we find Bernadotte's Corps (20,000 infantry besides other arms) occupying a depth of 14 miles; on the following day the head of this column marched 25 miles and the rear 30 miles, so that the Corps was billeted that night in a depth of 7½ miles. Similarly Davoust's Corps occupied a depth of 12½ miles on the evening of the 7th, and closed up to 7½ miles on the 8th, on which day the head marched 27½ miles and the rear 32 miles. This process was continued until, on the eve of battle, each Corps was concentrated in bivouac at the close of the day's march.

As an illustration of the staff work involved in movements of this kind, General Bonnal reproduces a scheme, which was set when he was on the staff of the Ecole Supérieure de la Guerre in 1888, together with his own solution and that of General Maillard. The problem was to move an Army Corps already on the march, to a place 47 miles distant where it was to be concentrated at the end of the third day; as the road was only to be available during certain hours of each day the distances to be traversed by the head and the rear of the column, respectively, on each day required somewhat nice calculation. The solutions contain examples of graphics, such as any staff officer can construct for himself, by which calculations of this sort may be simplified.

In conclusion, General Bonnal observes that, with the large numbers which would nowadays be brought into the field in a war between France and Germany, the unit would no longer be the Army Corps, nor even the Army, but the Group of Armies. An Army of 3 Corps would, he suggests, occupy at the close of each day's march a square of 12½ miles side—or of 19 miles side if the Army has 4 Corps. A group, consisting of a central Army of 4 Corps with 2 flank Armies of 3 Corps each (not including parks and convoys) might occupy a rectangle with 60 miles front and 40 to 50 miles side, allowing for intervals of 6 to 9 miles between Armies of the same Group.

The reasons advanced by General Bonnal in favour of a disposition in depth for a column halted at the end of a day's march, appear to apply with equal force to the movements of formations smaller than an Army Corps. The subject is, therefore, one that is well worthy of study in this country.

MISCELLANEOUS.

Comments on Military Questions and Current Affairs. (Questions de critique militaire et d'actualité). By General H. Bonnal. 203 pp. 8vo. Paris, 1911. Chapelot. 2s. 4d.

This little collection of essays and articles from the pen of the distinguished French writer, General Bonnal, deals with a variety of subjects tactical, historical, and personal. In the latter category are included biographical notices of the late General de Galliffet, the hero of Sedan, of the late Georges Gilbert, author of the "Essais de critique militaire," and of General

Digitized by Google

Cherfils, the cavalry commander, formerly on the staff of General de Galliffet, all written in terms of warm admiration, but tinged with extreme bitterness against the ruling authorities.

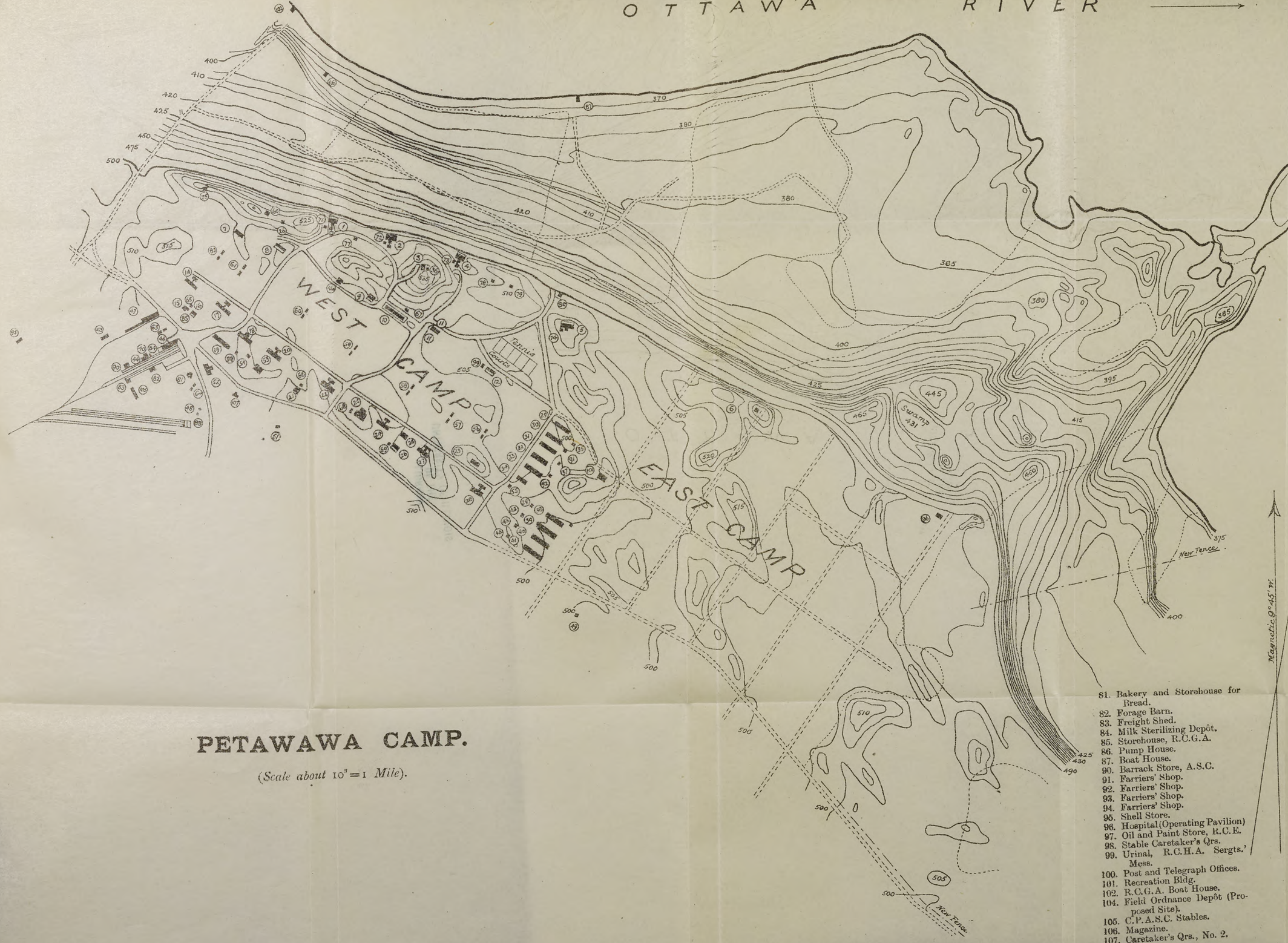
The two first articles reveal General Bonnal's marked distrust of the school of tactical thought, of which General Percin is the chief exponent. In the first article (*L'Infanterie aux Grandes Manœuvres*) he contends that General Percin's views on the speed at which infantry can advance during an attack are based on the experience of manœuvres rather than of war; he then proceeds to urge that no matter how slow the advance to the final fire position may have been, the assault itself should be carried through in the minimum time. In the second article he again joins issue with General Percin on the subject of communication between infantry and artillery in battle.

General Percin relies too much, in the author's opinion, on material means and on over-systematized methods of communication which may work well, up to a point, at an artillery practice camp, but which would fail in war; on the other hand he takes too little count of the importance of moral factors, such as the spirit of comradeship, unity of doctrine, etc., which, General Bonnal contends, may be developed until mutual co-operation becomes almost an instinct, as is evidenced by the admirable co-operation of the artillery and infantry of the 11th Army Corps at Woerth.

In "Napoléon et la marche sur Vienne" General Bonnal discusses Napoleon's failure to follow up the Archduke Charles after the latter's defeat at Eckmuhl (April, 1809). The decision to move on Vienna was, in his opinion, a grave error, and must be attributed to a certain deterioration of character, the result of overweening self-confidence, which obscured his judgment. The "Campagne de Sedan" gives, in the form of personal reminiscences of a battalion commander, a tragic picture of the indiscipline and disorganization of MacMahon's Army. In "L'Armée Française de 1870" General Bonnal combats M. Emile Olliver's assertion that the French Army was really ready for war in 1870; he insists, with apparent reason, that the mere existence of the troops and munitions cannot be said to constitute readiness, if the organization for employing them is totally lacking; the whole system of command and staff organization was, he maintains, based on the Napoleonic model, which presumed the availability of a genius as Commander-in-Chief, instead of relying on a high average level of ability among a well-trained General Staff.

The last of the historical essays gives a pathetic account, not without a touch of humour, of the misfortunes of four veteran dragoon regiments of the Army of Boulogne, who had been dismounted with a view to finding fresh horses in England, and, on the transfer of the army to the Rhine (1805) found themselves, to their mortification, making forced marches with the infantry, amid the jeers of other cavalry regiments, composed largely of raw conscripts. The murmurs of the indignant dragoons at length reached Napoleon's ears, and immediate orders were issued for these men to be exchanged with conscripts from the mounted regiments; but it was too late, as the mounted troops had already gone forward out of reach. The dragoons appear to have suffered so seriously in *moral* as a result of this treatment, that they fell into disfavour with Napoleon for many years.

Digitized by Google



PETAWAWA CAMP.

(*Scale about* 10" = 1 *Mile*).

REFERENCE.

1. No. 3 Officers' Mess.
2. No. 2 Officers' Mess.
3. Headquarters Offices.
4. No. 1 Officers' Mess.
5. Hospital.
6. Artillery Association Bldg.
7. No. 4 Sergeants' Mess.
8. No. 3 Sergeants' Mess.
9. Pay Office.
10. Regimental Offices.
11. No. 2 Sergeants' Mess.
12. No. 1 Sergeants' Mess.
14. No. 7 Men's Mess.
15. Armament Artificers' Shop.
16. West Branch Canteen.
17. No. 6 Men's Mess.
18. R.C.E. Store.
19. R.C.E. Stable.
20. No. 5 Men's Mess.
21. Guard House.
22. No. 4 Men's Mess.
23. Camp Institute.
24. No. 3 Men's Mess.
25. Artillery Store.
26. East Branch Canteen.
27. No. 2 Men's Mess.
28. No. 1 Men's Mess.
29. No. 1 Stable.
30. No. 2 Stable.
31. No. 3 Stable.
32. No. 4 Stable.
33. No. 5 Stable.
34. No. 6 Staff Stables.
35. Forage Shed.
36. H.Q. Bath and Closet.
37. Forage Shed.
38. No. 7 Stable.
39. No. 8 Stable.
40. No. 9 Stable.
41. No. 10 Stable.
42. Forage Shed.
43. Forage Shed.
44. Cold Storage Bldg., A.S.C.
45. Ice House.
46. A.S.C. Depôt.
47. Ordnance Depôt.
48. Caretaker's Quarters.
49. Veterinary Hospital.
50. Telephone Exchange.
51. Gas House.
52. A.S.C. and C.O.C. Men's Mess.
53. Carpenters' Shop.
54. Plumbers' Shop.
55. Latrine, Stable.
56. Latrine and Urinal, R.C.O.
57. Latrine, "A" Battery.
58. Latrine, "B" Battery.
59. Latrine, R.C.R.
60. Latrine, R.C.R.
61. Latrine, R.C.E.
62. Latrine, R.C.G.A.
63. Latrine, C.O.C.
64. Latrine, A.S.C.
65. Urinal, West Canteen.
66. Urinal, Guard House.
67. Urinal, Administration Bldg.
68. Urinal, Institute.
69. Urinal, East Canteen.
71. R.C.G.A. Officers' Lavatory.
72. R.C.R.E. Officers' Lavatory.
73. R.C.H.A. Officers' Lavatory.
74. R.C.O. Officers' Lavatory.
75. R.C.G.A. Bath and Closet.
76. R.C.E. Bath and Closet.
77. Staff Bath and Closet.
78. R.C.H.A. Bath and Closet.
79. R.C.R.A. Bath and Closet.
80. R.C.O. Bath and Closet.
81. Bakery and Storehouse for Bread.
82. Forage Barn.
83. Freight Shed.
84. Milk Sterilizing Depôt.
85. Storehouse, R.C.G.A.
86. Pump House.
87. Boat House.
90. Barrack Store, A.S.C.
91. Farriers' Shop.
92. Farriers' Shop.
93. Farriers' Shop.
94. Farriers' Shop.
95. Shell Store.
96. Hospital (Operating Pavilion)
97. Oil and Paint Store, R.C.E.
98. Stable Caretaker's Qrs.
99. Urinal, R.C.H.A. Sergts.' Mess.
100. Post and Telegraph Offices.
101. Recreation Bldg.
102. R.C.G.A. Boat House.
104. Field Ordnance Depôt (Proposed Site).
105. C.P.A.S.C. Stables.
106. Magazine.
107. Caretaker's Qrs., No. 2.

Digitized by Google

GENERAL VIEW OF MUSEUM, SHOWING THE NEW GALLERY.

Digitized by Google

THE R.E. MUSEUM.

By MAJOR W. A. HARRISON, LATE R.E.

Now that the reorganization of the R.E. Museum is almost completed, a short account of its history and contents may prove of interest to readers of the *R.E. Journal.*

Although from soon after the foundation of the S.M.E. articles of interest were collected together in the Model Room, which was used both as a Model Room and Church, the first attempt at an organized Museum dates only from the completion of the R.E. Institute, when one of the largest rooms was set apart as a Museum under the charge of the R.E. Institute Committee.

A further advance was made towards the end of 1880, when, on the motion of Major and Brevet Colonel (now Sir Richard) Harrison, C.B., a sub-committee consisting of Lieut.-Colonel (afterwards Sir J.) Donnelly, Capt. (now Sir H.) Jekyll, and Lieut. L. Darwin, with Major R. Vetch as Secretary, was formed to consider "how best to furnish and arrange the Museum at the R.E. Institute at Chatham."

This sub-committee reported towards the end of 1881 that there were "two Museums" (*a*) The Model Room which was not under the management of, or in any way connected with the R.E. Institute Committee, and (*b*) The Museum Room in the R.E. Institute, which was under the management of the R.E. Institute Committee. It was of opinion that the two rooms should be under one authority by whom the collections might be rearranged, duplication avoided, and the space used to the best advantage. It suggested therefore that either the room in the Institute be handed over to the S.M.E., or that the Model Room and its collection be handed over to the R.E. Institute Committee, and it recommended the latter as the better course.

It further recommended that a sub-committee composed of the Commandant and two members of the Institute Staff be appointed to manage the amalgamated museums. Colonel Donnelly did not entirely approve of the latter suggestion and added "I am anxious to bring the following paragraph of the Draft Report before the Committee of the Institute though my colleagues do not concur in it, because I am strongly impressed from all my experience that the primary condition of a good Museum is a good curator—someone *directly* charged to keep it up and constantly at work in it. A committee may very well manage or supervise, but there must be someone to do the work." The paragraph of the Draft Report

Digitized by Google

referred to was :—"In conclusion we venture to express a hope that the Committee of the Institute will provide a curator for the Museum. We believe that as soon as it is generally known that it has thus been put on a proper footing many officers of the Corps will be glad to contribute when they know what classes of objects are required."

Unfortunately Colonel Donnelly's suggestion was not approved by the Committee, but time has shown how thoroughly justified he was in his contention. This report was referred to the Commandant, S.M.E., for his observations, and he was asked, if he approved of it, to take the necessary steps to effect the transfer. This he did, and in 1882 his application was sanctioned and authority was given to transfer the charge of the Model Room to the R.E. Institute Committee, on condition that it paid any costs of upkeep, etc. A resolution proposed by Colonel Harrison and seconded by Major (afterwards Sir F.) Marindin was carried that "the charge of the Model Room be accepted by the R.E. Institute Committee on the terms set forth by the D.A.G." As already mentioned, the proposal to provide a curator was not approved and the management was handed over to the sub-committee as proposed in the report.

In 1890 the Museum was handed over to the S.M.E. on condition that "it still remained the property of the R.E. Institute." This arrangement was apparently entirely forgotten in the course of a few years, and by 1902 both museums had practically ceased to exist, the exhibits were crowded on one side, whilst the room in the Institute was converted into a class room and the Model Room was principally used for concerts and dances.

After the South African War the want was again felt of some place in which to exhibit the trophies and relics of the Corps, and in 1904 the Colonels Commandant discussed at their meeting the possibility of providing a Corps Museum, and General Sir R. Harrison proposed at the Annual Corps Meeting that "this meeting thinks that instructions should be issued to the R.E. Institute Council to take up as soon as possible the question of the provision of a Museum for articles of interest collected by the Corps."

This proposal was carried unanimously, but for some years nothing further was done, owing partly to the proposed transfer of the Headquarters of the Corps, and partly to the difficulty of finding suitable accommodation. In 1908, however, the question was again raised and a Committee to formulate a scheme for providing a suitable Museum was appointed, with Sir R. Harrison as President, Colonels J. A. Ferrier and F. Rainsford-Hannay as Members, and Major W. A. Harrison as Secretary. There was no chance of Government providing a Museum and the cost of a new building was prohibitive. The only suitable existing building was the Model Room and the Commandant was unable to spare this until a suitable place was

Digitized by Google

provided in which to hold the concerts, dances, etc. The Committee recommended that this might be done by enlarging the existing lecture theatre. The two end schoolrooms and passage were to be made into a stage and thrown into the main hall, and two new schoolrooms added to replace them. The Commandant agreed that this would provide a suitable substitute, and the scheme was approved at the Annual Corps Meeting of 1909—the Council being authorized to sell out £1,750 worth of Stock to cover the cost of structural alterations. Official sanction was also obtained, the Army Council undertaking that "although no guarantee can be given that the Model Room can be retained permanently as a museum, still so far as the interests of the public service will admit the R.E. Institute will not be disturbed in its occupation.' The alterations to the theatre were carried out by the S.M.E. workshops and were completed by the end of 1910, when a sub-committee was formed with Sir R. Harrison as President, the Commandant, S.M.E., and Colonels N. Lake and C. F. Close as Members, and Major W. A. Harrison as Secretary, to report "upon the alterations it considers advisable in the existing Model Room, and to decide which models, etc., at present in the room shall be retained for the Museum." At its suggestion, Colonel E. H. Hemming was co-opted on the sub-committee and was asked to submit a design so as to make the Model Room suitable in every way for a Museum. This he did with a success which may best be judged from the accompanying photographs. The work was most satisfactorily carried out by Messrs. Harrod, and was completed towards the end of last year, when the collection and arrangement of exhibits was taken in hand.

General Arrangement of the Museum.—In the first place it has been decided that, although the Museum is primarily intended for trophies of the various campaigns, peace relics of general Corps interest as well as old uniforms, will have a place in it. It has also been arranged to subdivide the Museum into sections by large screens, each section representing either a separate campaign or group of campaigns. This plan has been carried out, the chosen campaigns being :—(1) The Siege of Gibraltar, (2) The Peninsular War, (3) The Crimea, (4) The China Expedition, (5) Egypt and the Soudan, (6) The South African War, and (7) The Abyssinian and Zulu Campaigns and minor wars in East and West Africa. Two smaller sections have been allotted to the various Indian Campaigns, one to early campaigns and one to Corps records and peace relics of interest. Down the middle of the Hall are three cases containing the batons, medals, decorations and personal objects of our first three Field Marshals, and finally the Gordon relics are placed in the right-hand portion of the gallery.

A good deal of difficulty has been encountered in sorting out the mass of models and "exhibits" which had been stowed away under the galleries, so as to see what was really worth keeping. Profit-

Digitized by Google

ing, however, by the lesson taught by the original disregard of Sir J. Donnelly's warning, the Council has approved the appointment of an excellent curator—Mr. (late C.S.M.) Whiffen—and it is mainly owing to his exertions that the history of each exhibit has been carefully looked up, objects of value have been put aside and objects of little interest have been got rid of. The descendants of former officers of the Corps have also been appealed to, and have given or loaned many most interesting articles, until the nucleus of a really valuable collection of Corps relics has been formed.

It is proposed to give a short account of some of the principal exhibits in the various sections, and from it the Corps will be able to form some opinion of how thoroughly the Institute is trying to carry out its wishes.

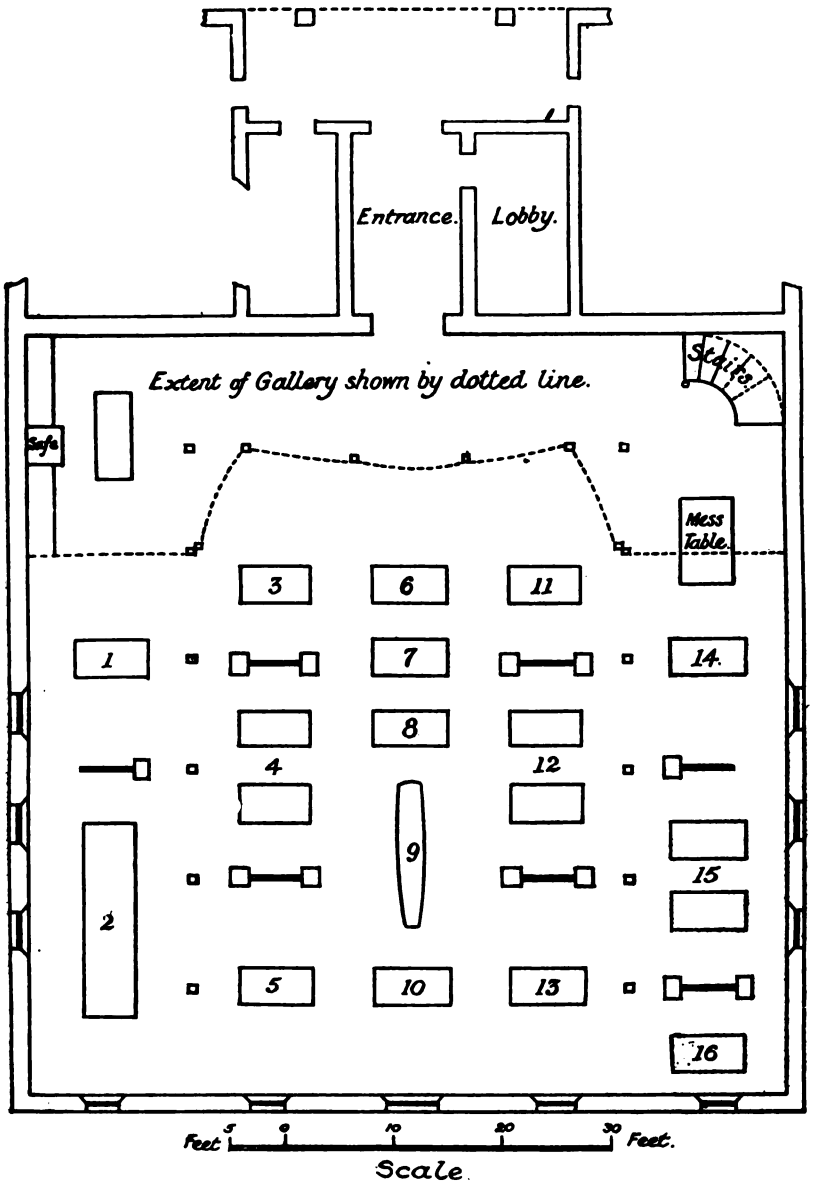
Early Campaigns.—Under this heading are grouped any records of the various early campaigns and expeditions which can be found. The earliest is a MS. diary and plan of the Siege of Barcelona in 1706, during the War of the Spanish Succession. It was presented by the late Major-General E. R. James and was compiled by his ancestor, Colonel Jacques St. Pierre, who acted as Chief Engineer to the expedition. A full account and transcript of it, written by General James, appeared as a *Professional Paper*.

The original MS. Engineer records of the Siege of Belle Isle in 1761, as well as many documents relating to the mission to Syria in 1798 are also in this section. The Syrian Expedition was originally under the charge of Brigadier-General Koehler, R.A., but after his death, Sir C. Holloway, R.E., commanded. The MSS. comprise Lord Grenville's original instructions on the scope of the mission—which was intended to aid the Sultan of Turkey in driving Bonaparte and the French out of Egypt—a notice of the intention to send out Abercromby's Expedition in 1800, one or two letters from R.E. officers describing battles between the Turks and the French, and finally an interesting copy, in Sir C. Holloway's handwriting, of his summons to surrender, sent to the French garrison of the citadel of Cairo after Sir R. Abercromby's victories at Aboukir and Alexandria. In addition to the above expeditions, are two very interesting old atlases, lent by the Army Council, one containing the early maps of Canada and the American Colonies, as well as plans of some of the more famous sieges such as Quebec, etc., and the other containing the plans of the various battles and engagements during the American War of Independence. There are also some MS. plans made by R.E. officers during this campaign as well as the original lists of Engineers entitled to prize money for a number of the minor expeditions.

Siege of Gibraltar, 1779—1782.—Gibraltar, as the birthplace of our rank and file, has, of course, a special Corps interest, and a section has therefore been allotted for the relics of the great siege in which Sappers played so conspicuous a part.

Digitized by Google

GROUND PLAN OF MUSEUM.



REFERENCES.

1. China.
2. Siege of Gibraltar.
3. Egypt and Soudan.
4. Early Campaigns.
5. Early Records.
6. Sir J. Burgoyne.
7. Lord Napier.
8. Sir L. Simmons.
9. Brennan Torpedo.
10. Miscellaneous Curios.
11. African Campaigns.
12. South Africa.
13. India.
14. Crimea.
15. Peninsula.
16. India.

Digitized by Google

The old model of Gibraltar has been repaired and occupies the centre of the section, and, in cleaning it up, Mr. Whiffen found an inscription engraved upon it which shows it to have been constructed by order of the Master-General of Ordnance in 1781. On the screen and round the walls are many of the MS. plans signed by Sir W. Green and made during the siege itself. Also a series of drawings of the batteries, etc., made by Lieut. Koehler, R.A., and lent by the Army Council. There are, besides, the original plans of the galleries, and one of particular interest is a rough pen-and-ink drawing evidently prepared by Sir W. Green himself, and from which the others seem to have been elaborated. General Nicholls, R.A. (great-grandson of Sir W. Green), has kindly lent a number of interesting oil paintings of incidents of the siege, etc., and also Mrs. Green's original diary and Sir W. Green's Gibraltar Medal. An original MS. General Order issued to Sir C. (then Lieut.) Holloway, R.E., during the siege has also been lent, and the officers of the Mess in Gibraltar have contributed a model of one of the furnaces used for heating the shot, and also the original warrant making the Corps "Royal" Engineers and allotting it its place on parade.

The Peninsular War.—Owing to the great kindness of Sir Lawrence Jones (grandson of Sir J. T. Jones) the collection of Peninsula records is particularly interesting. Sir J. T. Jones kept all the letters and orders he received whilst acting as Brigade Major in the Peninsula, and Sir Lawrence has generously presented the most interesting of these to the Museum. They comprise several autograph orders from the Duke of Wellington, the principal of which is his original orders for the final assault on Badajos. These are without doubt written by Wellington himself, and contain several corrections and marginal notes also in his handwriting, as well as a couple of pages of "Additional Orders" evidently added hurriedly as they are completed in pencil only. These orders were transcribed in full in the January *Journal.* Capt. Squire's MS. reports on the first and second unsuccessful sieges of Badajos; Sir A. Dickson's report on the artillery operations at Olivença, Ciudad Rodrigo and Badajos; Sir H. Clinton's autograph report on the operations of the divisions under his command in the various battles, also Sir C. Colvile's; numerous descriptions and reports of the various battles sent in by R.E. officers to the C.R.E.; the original diaries of Sir J. T. and Sir Harry Jones; Sir R. Fletcher's autograph order book and Reid's diary of the Siege of Burgos, are amongst the many papers. The whole of the original correspondence between Sir R. Fletcher and Sir J. T. Jones on the Lines of Torres Vedras, as well as Lord Wellington's original appreciation of the situation in the Peninsula in 1809, and his instructions to Sir R. Fletcher to examine and report upon the various positions and details in connection with the Lines, have also been given to the Museum by Sir Lawrence Jones. On the screens and walls are a

Digitized by Google

number of water-colour drawings of various places in the Peninsula made by Sir C. Ellicombe during the war. Amongst the old original trophies in the Model Room were a number of grenades and cups used in firing the rockets, musquetoon shells, a miner's trolley, a petard and other relics actually used during the war and sent to Chatham early last century. These have all been carefully sorted out and classified by Mr. Whiffen, and in conjunction with a portion of the original obstacle used in the breach at Badajos, and the sword taken by Sir H. Jones from a French officer whilst a prisoner in San Sebastian, form a most interesting collection of Peninsula relics.

The Crimea.—Amongst the Crimean relics are the whole of the diaries of the Siege of Sebastopol; many of Sir H. Jones' letters during the siege; a number of the original plans made by our officers during the siege; numerous muskets, fireballs, grenades, drums and other old trophies which have been sorted out by Mr. Whiffen, a rope mantlet used in Sebastopol, and the original mess table used by our officers and made out of old mortar platforms. On the walls are several contemporary drawings of the Crimea and the original duty diagram of officers in the trenches. The V.C. and French Medal of Honour won by Sapper Perie, which have been lent to the Museum, are also in this section.

The China Campaigns.—In the China Section are, amongst other things, several old Chinese weapons captured in 1860; an embroidered screen captured at the Summer Palace and lent by Sir R. Harrison; a "torture box" used by the Chinese, numerous original sketches and plans made at the time and given by Sir R. Harrison, and also two interesting plans and letters from General Gordon whilst in command of the "ever victorious" army.

The Indian Campaigns.—Although comparatively speaking there are but few relics of our Indian campaigns, the original diary of the Siege and Capture of Madras in 1758-9, the diaries of the Siege of Bhurtpore, the diary and order book kept by the 23rd Company during the Mutiny, and the *Kandahar Gazette*, a MS. journal kept throughout the siege during the last Afghan War, are all of interest. On the walls are four coloured engravings made by Lieut. (afterwards Sir T.) Aubury of the Engineers in 1799, and also a number of Indian weapons. There are but few relics of the Mutiny. Sir R. Harrison has kindly lent a sword which he captured in the assault on the Kaisar Bagh and which is believed to have belonged to one of the princes.

Some of the original sketches made during the Mutiny are hung on the screens and there is also a most interesting old MS. survey of a portion of Afghanistan, undated but evidently made early last century on paper water-marked 1821.

Egypt and the Soudan.—This section is still almost empty, the signboard of Tel el Kebir Station, a drum and rifle taken at Tel el Kebir, a Dervish djibbeh and the original "boat orders" issued by Sir

Digitized by Google

R. Buller during the advance up the Nile, forming the whole of the relics of the Egyptian War and of the many Soudan campaigns. There is little doubt, however, now that the Museum has been put on a satisfactory basis, that many trophies will in course of time be sent, as so many officers took part in the campaigns which are so specially connected with the Corps.

South African Section.—Unfortunately the same remark as above applies to this section. Although the Corps was so particularly associated with the war the Section only contains a few maps made on service, one or two interesting documents, a pom-pom shell and cartridge taken at Paardeberg, some Boer bandoliers and cartridges given by the late Colonel J. L. Irvine, and a Boer mine, intended to blow up an armoured train, given by Major Henniker.

Amongst the most interesting of the many loans are Sir J. Burgoyne's bâton, medals and decorations which are being lent by his granddaughters, Lady Barrington and Mrs. Morton Philips. The bâton and sword of honour of Lord Napier of Magdala as well as the black leopard skin stole presented to him by King John of Abyssinia and the flag of his Division in China (the first British flag ever planted on the walls of Pekin) have been kindly lent by his widow, the dowager Lady Napier. Mrs. Orman, daughter of Sir Lintorn Simmons, has lent not only his bâton, medals and decorations but also numerous personal objects of the greatest interest. Mr. C. H. M. Lennox is lending his father's medals and decorations amongst which is the first V.C. won by the Corps.* The medals and decorations, uniform and other interesting personal objects of General Sir John Cheape, G.C.B., are being lent by his daughter, Miss Cheape. To Sir John, who obtained his commission in the Bengal Engineers in 1809 and who commanded in the Burmese War of 1852, probably belongs the honour of being the first R.E. to command a mixed force in the field.

The original MS. plan of Waterloo and the neighbourhood which was used by the Duke of Wellington at the Battle, and on which he roughly pencilled the position he wished to take up when giving instructions to Sir W. de Lancy as to how to place the troops, has also been lent to the Museum. This plan, which is on a scale of about 4″ to the mile, was compiled by the R.E. officers in Flanders in 1814 and 1815, under the orders of Colonel Carmichael Smyth, and on it is the following history written and signed by General John Oldfield, who was Brigade-Major, R.E., at Waterloo :—

"This plan consists of reconnoitering sketches of the position of Waterloo, and the adjacent country, made by order of Lieut.-Col. Carmichael Smyth, Commanding Royal Engineers in the Netherlands,

* Sir Wilbraham Lennox was awarded the V.C. for his gallantry in the attack on the Russian Rifle pits on November 20th, 1854.

Digitized by Google

by his Officers in the years 1814–15. One fair copy had been given to H.R.H. The Prince of Orange, when Commander of the Forces, a second was ordered for His Grace The Duke of Wellington, but not being in a sufficient state of forwardness this original plan was sent to the Field when called for by His Grace on the 16th June, 1815. It was in custody of Lieut., now Lt.-Colonel Waters, R.E., lost and recovered in a melee with the French Cavalry at Quatre Bras.

On the 17th upon the Duke deciding upon retiring on Waterloo, His Grace called on the Commanding Engineer for the plan, who took it from Brigade-Major, now Colonel Oldfield, Royal Engineers (to whose custody it had been transferred on his joining Head Quarters) and given to the Duke, by whom it was handed to his Quarter Master-General, Lieut.-Col. Sir William De Lancy, K.C.B., with directions to place the troops in position; orders being at the same time given to Lt.-Col. Carmichael Smyth, relative to his own Department.

This plan was on the person of Sir William De Lancy when that Officer was killed. It was recovered for Lt.-Col. Carmichael Smyth by Brigade-Major Oldfield from Lt.-Col. Sir Charles V. Broke, D.Q.M.-General at Cateau Cambresis on the advance upon Paris in June, 1815, since which time it has been with the papers of the then Lieut.-Colonel, but subsequently Major-General Sir James Carmichael Smyth, Baronet, C.B., K.C.H., K.M.T., K.S.W.

(Sd.) J. OLDFIELD, *Colonel,*
and Capt. and Brigade-Major,
Royal Engineers.
31st January, 1846."

It remained in the possession of Sir James Carmichael Smyth's family until about 1860, and was then lost sight of until it was purchased by the writer a couple of years ago. The plan consists of the various field sketches mounted on a canvas backing and the pencil marks made by the Duke on the 17th June are still plainly visible. In the left-hand bottom corner are blood stains of Sir W. de Lancy, on whose person it was when that officer was mortally wounded during the battle.

The "Gordon relics" are too well known to need description, but consist generally of his yellow jacket and other Mandarin coats, etc.; his frock coat as a Turkish Pasha; flags used or captured during the Taiping rebellion; the large map he used during the operations, and numerous objects of interest, plans, drawings, etc., made by General Gordon both whilst at Woolwich and after he had joined the Corps.

Amongst the early records of the Corps are some old Board of Ordnance orders relating to the fortifications of Portsmouth and other places in 1667–8–9, the original lists of all the Companies of Sappers and Miners in Flanders on June 18th, 1815, as well as the whole of the returns, etc., of the Army in France and the Netherlands between 1814–1818. There is also Sir J. Burgoyne's original sketch for a stand

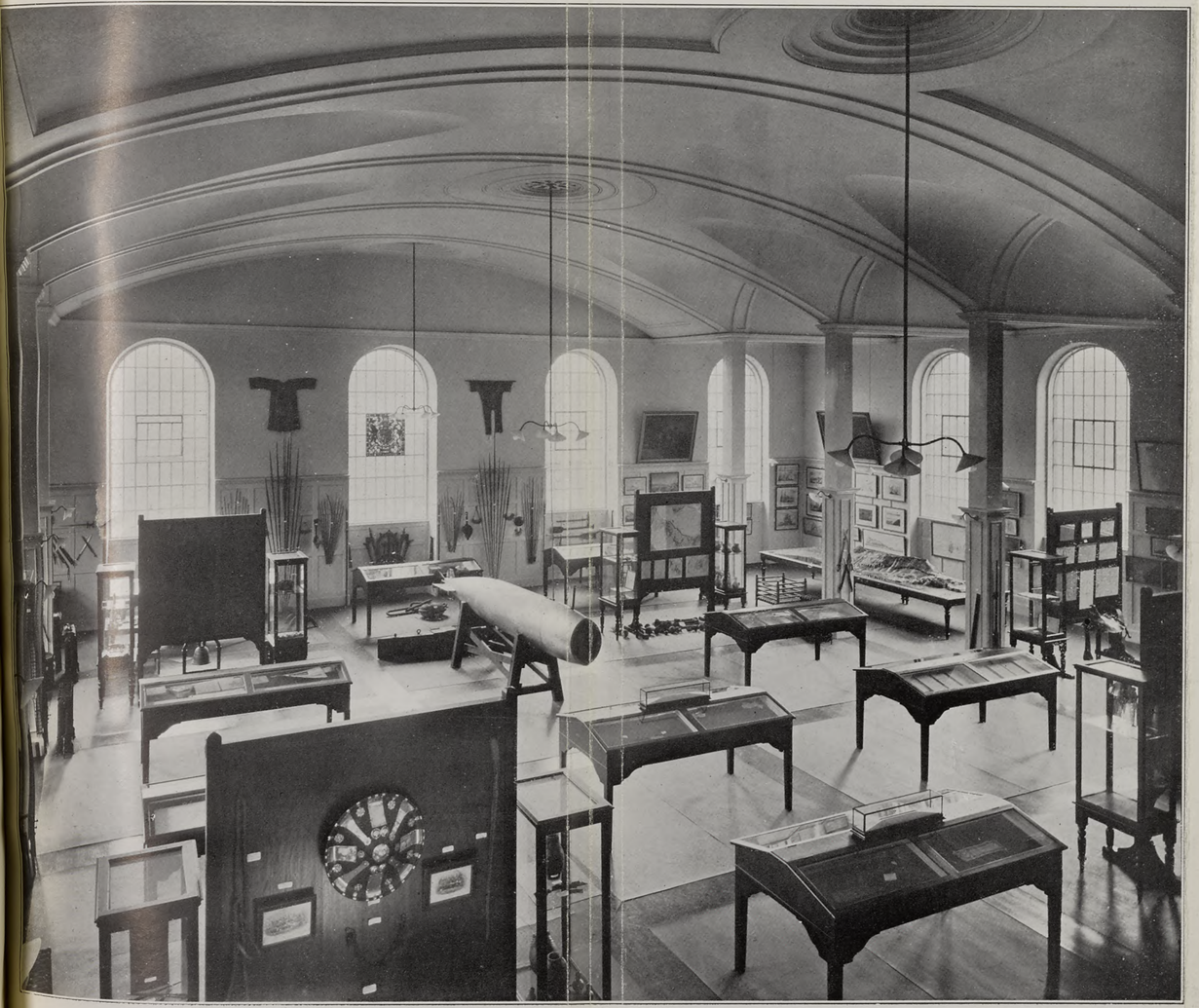
Digitized by Google

on which to test the ranges of muskets at different angles of elevation. These experiments were carried out at the S.M.E. and on them was apparently based the sighting of muskets for different ranges. A copy of Capt. Fowke's provisional patent for the bellows camera, dated 1856; a contemporary letter from Capt. (afterwards General) H. Sandham, giving a full description of the first submarine-mining operation ever attempted, viz., the blowing up of the brig *Kent* near Gravesend in 1838. There are also a number of beautifully drawn MS. plans of Chatham, Gravesend, Dover, Harwich and other places dating from about 1705, and finally the original model of the Brennan torpedo, brought over by Mr. Brennan from Australia, as well as a complete torpedo of the latest pattern have been handed over to the Museum. The above are only some of the many interesting trophies and objects which have already been collected, and it is to be hoped that now that the Museum has been put on a proper basis with a well-qualified curator, many more trophies will find a permanent home there. Flags of the Soudan and China Expeditions would be particularly acceptable, as, with the exception of a few boat flags amongst the Gordon relics and the flag of Lord Napier's Division, there are none in the Museum.

The entrance and small adjoining lobby have still to be put in hand and various other minor details require completion. In the centre window a stained glass panel of the Arms of the Corps has been inserted, and it is hoped some day to put similar panels, with the coats of arms of our most distinguished officers, in the other windows. As each panel costs about £20 it will probably be some time before this is done, but when finished it will still further greatly improve the appearance of the room. Still a good beginning has at last been made, and there is every reason to hope that, in a few years time through the co-operation of the officers and men of the Corps, the R.E. Museum will be one of which all can justly be proud.

Digitized by Google

GENERAL VIEW OF MUSEUM, TAKEN FROM THE GALLERY.



CROSS VIEW OF MUSEUM, SHOWING THE GORDON RELICS.

Digitized by Google

Digitized by Google

A SURVEY PROBLEM IN SIEGE WARFARE.

By CAPT. W. A. DE C. KING, R.E.

MUCH attention has of late been paid in the pages of the *R.E. Journal* to the work and tactics of Field Companies, R.E., while the work of the Siege Companies, R.E., of which there are now two in the Service, has not been discussed. The following sketch illustrating a Survey Problem in Siege Warfare is, therefore, submitted.

The scheme has been worked out to show, in detail, the survey work which would be required in a phase of subterranean warfare, and some methods of carrying it out.

In this warfare the general direction devolves upon an officer, R.E.—the "Controller of Mines." Under him are other officers for specially superintending the mining operations, one of whom is detailed to keep the plans.

General Idea.—In the general idea, it was assumed that a fortress had been invested.

Special Idea.—In the special idea, an imaginary "Zone of Investment" and the "Front of Attack" were described, it was also stated that a work "Z" was included in the "Front of Attack," that two sapheads had approached to within 700′ of the ditch of this work and that the officer commanding the attack had decided to resort to subterranean warfare.

Intelligence.—It was assumed that a certain amount of intelligence had been obtained in peace, and that aeronauts had obtained information during hostilities as to the defences of the ditch.

Preparations.—The general line of an imaginary entanglement and the two sapheads were marked by pickets, a 5″ theodolite being used. It is assumed that observations could be taken through specially constructed loopholes.

Work Carried Out.—Theodolite observations were taken from the two sapheads to a conspicuous point, the distances and heights were then worked out.

With the information obtained, the contoured plan (see *Plate, Fig.* I.) was taken.

Fig. II. shows the work "Z" viewed from the saphead "A."

SIEGE OF "Z" WORK.

Extract from Diary of Controller of Mines.

January 15th.—Two saps from the 2nd parallel have reached the points A and B as shown on *Fig.* I. The points A and B were

Digitized by Google

roughly fixed by triangulation from the 2nd parallel (assumption); but it will be necessary to ascertain the distance between A and B more accurately. Point A is approximately 375′ above M.S.L.

January 16th.—Set up a subtense bar 11′ long at A, and observed angle subtended by the rod from B by means of 5″ theodolite.

The total of the angles (10) being 12° 32′ 32″: the angle subtended by the rod being 1° 15′ 15″.

By the formula $x=\frac{11}{2}$ cot 1° 15′ 15″

$$AB=502{\cdot}5 \text{ feet.}$$

January 17th.—Parallel completed between the points A and B.

The distance was then measured with a 50′ steel tape and found to be 500′. Fortunately the trench was straight, and it was therefore possible to chain in a straight line, otherwise it would have been necessary to run a theodolite traverse.

For calculations, the length of AB is taken as 501 feet.

January 18th.—It has been decided to advance by mining from A instead of carrying on the deep sap the reasons being:—

(*a*). Necessity for secrecy.

(*b*). Owing to the steep drop in front, it would be impossible to construct saps with impunity. The objective chosen being point "P," the caponier in the salient.

Saps are being pushed forward on the flanks, and it is hoped that the besieged will be deceived as to our intentions.

January 19th.—Set up theodolite at A and B, and observed angles to the conspicuous points on the glacis, and to posts in the wire entanglement, as follows, *vide Plate, Fig.* II.:—

"P." Stone slab on top of caponier.
"Q." Telegraph pole.
"R." Straining post in wire fence on or near edge of ditch.
"S." Post in wire fence on or near edge of ditch.
"T." Post in fence running down the valley which is formed by slope in front of AB and the glacis.
"U." Ditto.
"V." Chimney.
"W." Ditto.
a, *b*, *c*, *d*, *e*, and *f*. Six conspicuous posts in the wire entanglement.

The angles of depression and elevation were observed to the feet of all posts.

Height of instrument at A, 5·25 feet.

Digitized by Google

Table of Observations.

	Observations from A.						Observations from B.		
	Horizontal Angles.			Vertical Angles.			Horizontal Angles.		
	°	′	″	°	′	″	°	′	″
A	—	—	—	—	—	—	0	0	0
B	0	0	0	−3	12	0	—	—	—
a	259	1	30	−2	27	0	29	50	0
b	259	7	0	−1	46	0	30	50	0
c	269	6	30	−3	30	0	33	5	0
d	267	52	0	−2	30	0	34	5	0
e	279	36	30	−3	35	0	39	3	0
f	278	20	0	−2	30	0	39	53	0
P	262	8	0	−2	6	0	44	0	0
Q	275	38	0	−0	45	0	48	10	0
R	252	2	30	−3	6	0	37	21	0
S	261	52	30	−2	6	0	40	8	0
T	262	47	0	−4	2	30	29	6	0
U	276	45	0	−6	56	0	30	56	0
V	250	50	0	−6	13	30	41	10	0
W	263	2	30	—	—	—	50	13	0

Table of Distances and Heights.

Point.	Distance from A.	Height above or below A.	Height above M.S.L.
	Feet.	Feet.	Feet.
a	312	− 8·099	367
b	330	− 4·928	370
c	328	− 14·811	360
d	350	− 10·031	365
e	360	− 17·294	358
f	378	− 11·254	364
P	560	+ 25·784	400
Q	510	+ 11·926	387
R	545	+ 34·706	410
S	480	+ 22·851	398
T	300	− 15·947	359
U	290	− 30·015	345
V	675	+ 78·876	453
W	725	—	—

The contours on *Plate, Fig.* I., have been drawn with the aid of the above, after an inspection of the ground from the sapheads.

January 20th.—It is decided to run an inclined gallery at a slope of 1 in 5 until the top of the gallery is 6′ below the ground and then drive the gallery straightt owards "P," keeping 6 feet below the

Digitized by Google

ground until a point is reached underneath the line of the fence TU (320 ft. measured horizontally).

No direction posts are to be allowed above ground.

To obtain direction of the caponier P, the objective set off at A, with theodolite, an angle of 97° 52′ 0″ (360°−252° 8′ 0″).

The true bearing of B from A is 129°, and that of P from A is 32° 30′. The depth of the ditch of the parallel at the point A, where the common gallery is to commence, has been increased to 8 ft. and then runs with a slight fall. The parallel is blinded at this portion for a short length to protect the mouth of the gallery.

The slope of the ground in front to the fence TU is approximately $\frac{1}{20}$. The gallery at $\frac{1}{5}$ must be therefore driven for a distance of 23′ (measured horizontally) the topsill will then be 6′ below the ground, the topsill of the first case is 2 ft. 6 in. below the ground line. From this point the gallery must be driven at a slope of $\frac{1}{20}$ for a distance of 297 ft. (measured horizontally); the topsill should then be 6 ft. below the ground at the line of the fence TU.

The angles of depression for slopes of $\frac{1}{5}$ and $\frac{1}{20}$ are 11° 18′ 35″ and 2° 51′ 44″ respectively.

The following is imaginary.

January 21st.—First case in position.

January 22nd.—Changed slope to $\frac{1}{20}$ at the 23rd case. Verified direction at this point with theodolite from A, observed on to a plumb line held in front of a sheet of paper behind which a candle was held, a horizontal line is marked on the paper for observing vertical angles, and in order to save calculation the paper screen is adjusted so that the horizontal mark and the axis of theodolite are the same distance from the topsills above them. Fixed small eye in 29th topsill from which the line can be plumbed when required for future reference. The line to objective has been marked with chalk on the underside of the topsill.

Found theodolite legs (short ones) difficult to manipulate in the gallery, so have tried fixing instrument on a stout plank supported by two blocks of wood which can be screwed into the stanchions of a case. The theodolite rests on a wooden base which can be clamped in position on to the plank.

As the project deals with the survey work of setting out the gallery only, it is unnecessary to carry it further—the later stages possessing no particular interest from this point of view.

Digitized by Google

STEEL CONCRETE CULVERTS.

By CAPT. E. D. CARR-HARRIS, R.E.

THE following are plans of steel concrete culverts which have been found useful in road work in those parts of the Frontier Province named in the table below.

Simplicity of design is at all times an advantage, and especially so when work has frequently to be carried out by unskilled workmen. For this reason only one class of steel ($\frac{1}{2}$" square bars) is used for all spans from 2′ up to 5′. The necessary variation in strength is given by spacing the bars at different intervals.

Twenty-six culverts, two bridges of 10′ span and one bridge of 30′ span, have been constructed on this design in the last six months and have all proved satisfactory.

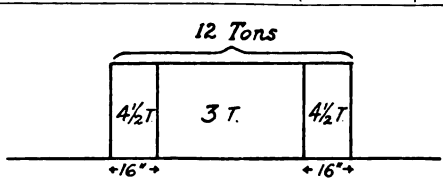
In the case of bridges, the steel concrete decking is carried on rolled steel beams, and the thickness of concrete is slightly reduced as the decking between any two rolled steel beams may be regarded as a fixed beam.

The designs are calculated for maximum load due to a moving steam road roller weighing 12 tons when fully charged with fuel and water. Factor of safety 4 with 9″ of filling on culvert, and the following is a summary of their design and cost :—

Summary of Foregoing Steel Concrete Slab Culverts.

Span of Culvert in Feet.	Size of Square Steel Bar Reinforcement.	Spacing of Bars C. to C.	Depth of Centre of Bar from Top of Slab.	Total Depth of Slab.	Cost per Foot Super of Reinforced Concrete Slab.								
					Kohat Sub-Division.			Samana Sub-Division.			Kurram Sub-Division.		
					Rs.	As.	P.	Rs.	As.	P.	Rs.	As.	P.
I.	II.	III.	IV.	V.	VI.			VII.			VIII.		
2′	½″	6½″	5½″	6¾″		12			12	6		14	
2½′	½″	6″	6″	7¼″		12	6		13			15	
3′	½″	5½″	6½″	7¾″		13			13	6	1		
3½′	½″	5″	7″	8¼″		13	6		14		1		3
4′	½″	4⅜″	7½″	8¾″		14			14	6	1	1	
4½′	½″	4½″	8″	9¼″		15	6	1			1	2	6
5′	½″	4¼″	8½″	9¾″	1		9	1	1	6	1	4	

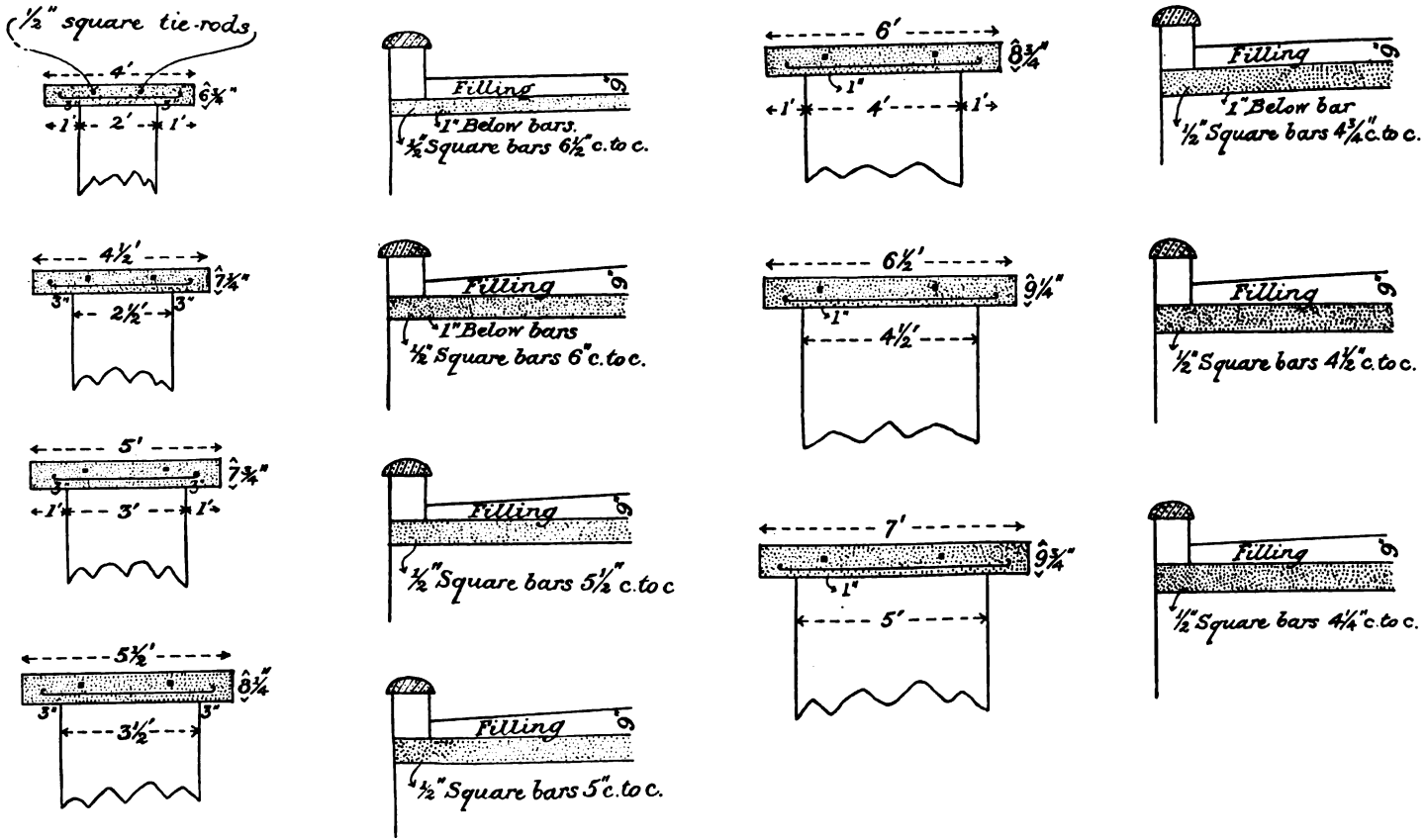
Concrete 4 *Aggregate*
2 *sand*
1 *cement*



Road Roller—Distribution of Weight.

Digitized by Google

MACADAMIZED ROADS, N.W. FRONTIER PROVINCE. STEEL CONCRETE SLAB CULVERTS. KOHAT STANDARD SECTIONS.



Reinforcement ½" steel bars. Ends of bars to be turned up 2". Two ½" square steel tie rods to be imbedded in centre of concrete at right angles to bars. Scale 4' to 1".

Digitized by Google

THE A.B.C. SYSTEM OF TRAIN CONTROL.

By MAJOR H. F. E. FREELAND, M.V.O., R.E.

GENERAL.

THE A.B.C. system of train control is so-called on account of its simplicity and was first instituted on the Northern Pacific Railway between Spokane and the west coast; it is in effect a combination of the "Despatcher," or American standard, system of operation and the "line clear" system as practised on Indian railways. Under the provisions of the former one responsible control directs the movements of all trains within a certain area, while under the latter no train may enter a section unless an assurance has first been received that the line is clear of obstruction. The American standard system while making for efficiency leaves much to be desired in the matter of safety and is abandoned without hesitation when the density of traffic demands closer attention to safety of movement. The Indian "line clear" system on the other hand regulates with care the passage of trains over each "station to station" section in turn but the control exercised is purely local and does not provide for the efficient direction of a large mass of traffic moving at varying speed over long distances.

On the Northern Pacific the problem to be faced was briefly this:— Sixty-three miles of single line, through mountainous country, with stations averaging 4 miles apart, was called upon to carry a constantly increasing traffic, and it was found that the greatest number of trains that could be run each way, under the standard American system, was 18 per diem. The only solution appeared to be the doubling of the line, a very costly business on account of the heavy bridging, cutting, bank and tunnelling work to be executed; as an alternative it was suggested that the A.B.C. system should first be tried. It was accordingly installed with the result that the maximum was at once increased from 18 to 25 trains a day each way, and the cost of doubling the line indefinitely postponed. The telephone was used as the means of intercommunication between the Controller at Spokane and the operators at roadside stations.

When traffic is small or all trains are timed at a more or less uniform speed over the division between engine-changing stations the difficulties of operation are reduced to a minimum but when a heavy long-distance traffic requires to be handled and fast trains are to be

Digitized by Google

run up to their scheduled time through a mass of slow moving traffic without seriously disorganizing the latter, it will be generally admitted that some system which provides for direction from a common centre promises the best chance of success. Whether such a system is to be adopted or not is largely a consideration of relative cost.

The most confirmed optimist will agree that goods trains very rarely run up to a time table, or in other words a goods train time-table is hardly ever of any value for the purpose of locating the position of the train at any time because there are so many unknown factors in the calculation; they must give way to faster traffic, and the amount of shunting and other work to be done day by day varies considerably. If anything is certain in railway operation it is that given a dense passenger traffic goods trains will be held back to give it precedence.

Consider what happens when a train service becomes disorganized and important trains run persistently late; orders are sent out to all stations on the offending division pointing out the necessity of showing better results and Inspectors—even officers sometimes—are specially detailed in the hope of improving matters. Attention is fixed on a certain late running train for the time being with the result, more often than not, that other equally important trains suffer. Endeavours to keep a "difficult" train to time usually bring to light some defect in the existing time-table for the district concerned, and opinion is reluctantly formed that no permanent improvement can be effected without a radical alteration of the whole. A new time-table is in due course brought into force with probably many other defects merely because the enquiry which has brought about the alteration has been centred on the running of one particular train to the exclusion of others the importance of which is not felt until they, too, commence to run out of course.

It should be remembered that trains in India run comparatively very long distances, and this applies to goods as well as to passenger traffic; the former cannot, as in many countries differently situated, be kept off the road to allow the latter free movement.

The making of a time-table is an art in itself, requiring, if it is to be successful, very precise knowledge of local conditions; the more dense the traffic the more difficult it is to allow a margin which will obviate the diso.ganization of the remainder of the service when an important train runs late. The time-tables of a railway are prepared by an expert after full consideration of the special requirements of traffic for the different seasons of the year; these requirements are brought to his notice by the officials located at various points on the system, and with full information at his disposal there should be every reason to hope that the expert may get out a scheme of movement which, as far as fast passenger and mail trains are concerned, will be satisfactory. But although an expert can, with

Digitized by Google

the information usually placed at his disposal, prepare a time-table which will normally give good practical results, a sudden and temporary change of conditions at some point will upset all his carefully calculated scheme. The effect of a train running late in such a country as India, where through connections are to be made over many hundreds of miles, is far greater than is generally supposed, and the denser the traffic the more far-reaching the effect. Such being the case how can a high standard of efficiency be maintained with a purely local and inelastic system of working in force and without some central authority having a comprehensive view of the whole situation at any moment and power to direct the general movement? The personal element merits consideration in every country in the world, and in India very particularly; then consider what happens to a train after it leaves one engine-changing station to run, say, 100 miles to the next and to pass, say, 20 small roadside stations manned by Indian station masters. All goes well while the whole service is working up to time, but as soon as one train runs late, crossings are thrown out, and the efficiency of the service is entirely at the mercy of the individual faults and idiosyncrasies of the local Indian station masters at each of the 20 roadside stations, who are probably not very intelligent or reliable, and who have no knowledge of the general situation beyond their station limits, or having it would in most cases be prone to sacrifice the general good to their own station's convenience.

These men, it must be allowed, are generally keen enough to keep the passenger service up to time, because, if they are not, punishment is certain to be meted out in some form or other. Their one idea appears to be to shift the responsibility from their own shoulders to someone else's as quickly as possible; acting on this rule of life they will infallibly do all they can to get rid of a train from their station even at the cost of detaining at the station in advance another to give precedence to which would be advantageous to the successful movement of the whole. It may also be assumed with certainty that if there is an officer or an inspector present the Indian station master will gladly accept his orders in such a case, and so shift the responsibility.

Although of recent years the financial side of the question has come more and more prominently forward in India it has not, in the past at any rate, been generally considered necessary to pay much attention to the running of goods trains; they get through "somehow," until complaints begin to come in from train crews of long hours on the road and of irritating and seemingly unnecessary detention at roadside stations, where no work has to be done, but where they lie side-tracked for faster traffic to go through unchecked. Some consideration, however, is due to the fact that such detentions, even to goods trains, mean a bigger coal bill, greater wear and tear

Digitized by Google

on the keenness of the staff or an unnecessarily high establishment, and a considerably larger equipment in locomotives and goods stock than would otherwise be required.

A time must come, then, when the question of doubling a single line in order to compete with the rising traffic has to be considered, or when traffic on a double line becomes so dense or is so complicated by intermediate junctions as to be unmanageable by a purely local system of working.

It is at such a time that some central control agency can possibly be established with successful results and may as in the case of the Northern Pacific Railway put off the day when doubling has to be undertaken, or, as in the case of the Durbar Railway in 1911, handle an enormous double line traffic on a complicated network of lines with a degree of success which it is believed could not otherwise have been attained.

DESCRIPTION OF THE A.B.C. SYSTEM OF TRAIN OPERATION.

The A.B.C. system of train control is a system whereby the Controller or directing authority is in communication with operators at every station on his division, and by means of information obtained from them and with a visual record of the position of each train at any moment is enabled to make intelligent plans for the movement of traffic, and give intelligent orders for the precedence of one train over another.

The Control Office should be located at some convenient point on the division operated, which will vary in length according to the density of the traffic; on a busy single line this division will usually be an engine run of about 100 miles with stations situated 4 to 5 miles apart.

At the Control Station will be the Directing Staff, consisting of a Chief Controller, and his Deputy if traffic demands it, and three or more Controllers each doing nominally four hours' work at a time and up to eight hours during the periods when traffic is slack.

The Control Office should be connected with each station on the division by an independent telephone, which should be so installed as to enable the Controller to call up one or several operators simultaneously and which must be inaccessible to any but the Train Operating Staff. Each station on the division should also be connected with the station on either side by a local telephone set apart for train working only.

The general procedure is briefly as follows :—

It is required to send a train from A to an adjacent station B.

A will telephone to the Controller and ask for orders to be issued to run the train to B, or in many cases the Controller will take the initiative. If the Controller has no other movements in view over the Section A—B he will simultaneously telephone orders to A and B

Digitized by Google

to move the train, *if line is clear.* A will then ask B for line clear and if the line is clear B will give the necessary authority, all by telephone. As soon as the train leaves A, that station will telephone the departure timing to B and to the Controller, and as soon as the train reaches B, that station will telephone the in-report to the Controller and to A; this completes the transaction.

The chief point to remember is that no train may leave any station to run to another unless the Controller has first given orders in the prescribed manner for it to be started *and* unless a line clear has been obtained in the usual way from the receiving by the starting station.

Control Office Equipment.

Control Table.

In order that the Controller may be able to give his orders in a manner conducive to safety and efficiency, he should be provided with a long table the face of which is formed of as many countersunk parallel grooves as it is estimated will correspond with the maximum number of trains to be handled simultaneously. The Controller sits in front of this table which is arranged so as to move to his right or left on runners; this enables him to move up into a convenient position any particular groove requiring his attention and obviates the necessity of moving his chair. The grooves run transversely across the table and are capable of receiving what is known as "Train Slips" (see specimen attached) which will be run in from the bottom of the groove (nearest the Controller). Each groove is also equipped with a small red pointer, which can be moved by means of a handle or lever situated at the bottom of the groove, up or down to the position occupied by the train, the movements of which are recorded by the Controller on the train slip in a manner to be described hereafter. This red pointer gives a visual indication on the table of a train's position and the lever or handle which operates it may with advantage be constructed so as to simultaneously change the position of discs on a line diagram, fixed upright at the back of the table in full view of the Controller and of his Chief. The diagram should show the whole division operated, and each running line, reception and departure siding at stations; the discs may either be moved electrically or mechanically the latter for choice. It can further be arranged that, if the Controller pulls his lever or turns his handle so as to bring the pointer and disc into a section already occupied by a train, an electric contact will be made, and cause an alarm bell to ring; the Controller can thereupon put the handle or lever back and is prevented from giving an order which he will have to cancel as soon as he is informed by stations at either end of the blocked section that line is not clear. Each groove has a small button at the top, which is inserted in a hole punched in the train slip and holds it in position.

Digitized by Google

Control Telephone.

The Control Office in order to call up any operator or be called up by him must be equipped with an exchange, which may be either of the ordinary modern type with plug switches, or a special selective instrument usually adopted for this work in America. A press key bell is more convenient than that operated by revolving a handle, and it is desirable to arrange for a subsidiary dynamo equipment in order that a more powerful current may be available in case "through orders" (to be explained below) require to be transmitted over long distances to several stations simultaneously.

The simpler the operation of the exchange can be made the more quickly will the Controller get through his work, the more trains he can handle successfully and the less strain there will be upon his powers of endurance.

The exchange should be fixed in a position right in front of the Controller's chair and within a short arm's reach, so as to lessen the fatigue entailed in working it; it is not desirable to have the exchange erected on the right or left-hand side of the table. To provide for this essential and at the same time to so place the diagram that it may be mechanically or electrically operated by the movement of the handles or levers on the table will not be easy. The diagram must necessarily be fixed to the table and move with it, but the width of the diagram board need not be very great and the exchange could be fixed to the wall behind the table and project out over it but clear of the diagram (*vide* sketch attached).

Train Slips.

A specimen of the train slip is attached. It is not necessary that the arrangement of columns or of the general information given shall be precisely as in this specimen which was that adopted on the Delhi Durbar Railways to suit the special requirements of the traffic.

The train slip for single line operation might well contain much more information than was considered necessary at Delhi; for example it would be easy to include details of vehicles attached and detached to trains at the various points.

The number of entries on a slip is only limited by the time at the Controller's disposal, and by the size of the slip, the width of which cannot much exceed $2\frac{1}{2}''$ in width or $15''$ in length, without necessitating a table of unwieldy and inconvenient dimensions.

The train slip is intended not only as an indication of a train's movement from station to station for the guidance of the Controller but also as a permanent and complete record of all movement of and work done by that train throughout the run.

The blank train slips, arranged in series ready for use should be

Digitized by Google

placed on a small table on the Controller's right hand; when the train has completed its run, its particular slip should be drawn out of the groove and, after being signed by the Controller, inserted by him in the drawer of his table through a slot provided for the purpose. Thus there should be no completed slips on the table to confuse the Controller by their presence. It will be found most convenient to allot one end of the table (say left) to up trains and the other (the right) to down trains, and to run a blank slip painted red into the centre groove so as to emphasize the division.

It may not be considered imperative to use private numbers or codes in the interchange of messages, but it is thought that this procedure will be found eminently desirable in practice, if only for the purpose of distinguishing between a large number of similar transactions between Controller and operators. To save the labour of writing out each private code or number on the train slip every time the Controller orders the movement of a train, it is as well to have these codes or numbers printed on the slips as shown in the specimen.

Miscellaneous Additions to Control Table.

The red pointer which, as has been explained, is moved on the ratchet principle step by step, up or down the groove, can then be so adjusted as to come to rest opposite the station's name, where the train actually is standing, so as to cover the private number or code which is to be given as the last word of the order for the train to move into the section in advance. Before he can give the order to move the Controller must uncover the private number or code by turning the handle or lever and moving the pointer, which with a half turn of the ratchet comes into the next section in advance, and while resting there reminds the Controller that that section is blocked. As each station name is so printed on the slip as to be in one horizontal line with the same station name on any other slip, it is obvious that a glance at the position of the red pointers, will show the Controller the situation on the whole division under his direction. In American practice the provision of these distinctive pointers is not considered essential, their train despatchers relying solely on the relative positions of the last entry on each slip to indicate the whereabouts of trains.

If the pointer is combined with a danger gong, which as soon as an attempt is made to move that pointer into a blocked section will indicate electrically when the section is already occupied, the advantage is obvious, because, although an accident would be obviated by the knowledge of the operators at each end of the section, the audible signal that the line is not clear will prevent the Controller from giving an order which he would inevitably be compelled to cancel.

Digitized by Google

Train-Ordering Procedure.

To consider now the operations which must be gone through by the Controller, when a fresh train comes under his hand. As soon as information is received from the starting station, be it a junction or engine-changing station, that a train will shortly be ready to leave, the Controller will select a train slip for the division over which the train will run and fill in the headings, viz. (in the case of the specimen attached) the train number, engine number, driver's and guard's names, load and date; he will then run the slip into a convenient empty groove on the up or down side of his table, as the case may be, and fasten it securely in position by means of the button at the top of the groove, then turn the red pointer so that it covers the private code opposite the name of the starting station. As the time for departure draws near he will enquire, from the station master if all is ready to start "to time," if not when will the train be ready. It is not desirable for the Controller to order the movement of a train too long in advance, for it should be remembered that the operators as soon as they have received the order will at once proceed to ask and give "line clear" and then lower their signal; five minutes before a train's probable departure is quite time enough to allow for the "line clear" operation. If then the Controller is assured by the starting station operator that the train will be ready to leave in five minutes, he will, if the section is clear ahead, move the red pointer one notch and expose the private code or number, which was concealed by it. His next step is to plug the starting and next receiving stations on his switchboard, ring them up simultaneously and order the train's movement, giving as the last word of his order the private code or number disclosed by moving the pointer on his table. This order will be acknowledged by the two operators who will, commencing with the starting station, repeat the train number and Controller's private code, a repetition which will be acknowledged by the Controller's "O.K." All three men will enter the time of the completed order in their records, which in the case of the operators is the Train Register and of the Controller the Train Slip; this concludes the transaction. The starting station operator will then ask "Is line clear for No.... (train number)" from the next receiving station operator and give as the last word of his enquiry the Controller's private code; if the line is clear of all obstruction, the last train having arrived complete, and the Controller's code is the correct one received by him the receiving station operator will give "Line is clear for No. ... (train number)" and give as the last word of the message his own private code or number from the printed list in his possession. The starting station operator is then in a position to issue an authority to proceed to the driver, and lower signals for the train to start.

All operators must be provided with the Control Train Order

Digitized by Google

Registers, in the columns of which will be recorded all private codes or numbers received from the Controller and the times thereof, and must also have line clear books where the times which trains pass their stations and leave or arrive at the stations in rear or advance respectively must be entered. These entries must be made in ink, and no erasures are permitted; if a wrong entry is made it must be cancelled by a clean horizontal line drawn through it, and the correct entry inserted immediately above. This rule as regards erasures applies more particularly to the Controller whose entries are considered indisputable; it is better that whenever the Controller finds it necessary to cancel an entry the Chief Controller should at once be asked to initial it.

All this takes a long time to describe, but the whole transaction of ordering a train's movement and of obtaining a line clear does not take more than from 15 to 20 seconds by telephone. It may so happen that the Controller orders the movement of a train into a blocked section, but as above insisted the ultimate responsibility for safety lies with the operators at each end of the section, and it is hardly likely that three men will all make the same mistake of acting as if a section is clear when it is actually blocked. The fact is that the Controller very rarely makes a mistake; in actual practice on the Durbar Railway it was unknown although the number of private codes given by the Control Office in ordering movements exceeded 70,000. From the moment he takes his seat at the table till the time comes for his relief, he is obsessed with the scheme of movement, constantly in difficulties owing to trains not doing what he expected, incessantly making plans as far ahead as possible, and altering them to suit new conditions as the situation develops, he has the whole division and the trains running mapped out in his head, and if he doesn't know exactly where a train is he is keen to enquire its whereabouts in order that his plans may proceed intelligently. The strain is severe, but he knows how much depends on his clever manipulation of the traffic and that he is the heart of the machine and is keen to maintain his reputation for efficiency; there is much less likelihood of a Controller ordering a train into a blocked section than there is of a driver running past signals at danger.

In addition to the ordinary Train Order there is the Through Train Order which is conveniently used when it is required to push an important train through two or more stations over a clear run. To give a Through Order the Controller will use the private code of the station at the commencement of the "clear run," and will cancel and initial those which follow it and are not to be called into use. For a "Through Order" several stations may require to be plugged on the switchboard simultaneously, and the power of the battery or dynamo must be sufficiently great to enable this to be done, as has already been indicated.

Digitized by Google

Line Diagram.

As has been mentioned above, the line diagram is a very useful adjunct to the Control Table, and provides an additional visual indication of the position of all trains on the division ; it should be fully visible from the Chief Controller's table or from any point in the room, and its existence will constantly make it unnecessary for the Chief to ask the Controller the whereabouts of a train in order to answer an enquiry on the telephone from the Station or District Office. This diagram if worked mechanically by the movement of the pointers on each groove must necessarily be part of the table ; if on the other hand the interlocking is designed to work electrically there is no reason why the diagram should not be fixed in one permanent position. Mr. E. A. Scott, the Signal Engineer of the N.W.R. of India, has designed a table and diagram combined which are admirably suited for the purpose and full particulars can be obtained from him.

Briefly the diagram consists of a distorted plan of the track on the whole division controlled, the various running lines and sidings at stations being clearly shown. In each line on the diagram, whether representing the track between stations or the running lines or sidings at the stations themselves, a circular orifice is pierced, through which may be made to appear from below a white, red or blue disc, according as the line is unoccupied, is occupied by a down train or by an up train respectively. These discs can, as has been stated, be moved into position either mechanically or electrically by the turning of the handle moving the red pointer along the grooves on the table.

The line diagram of the railways controlled by the Delhi Durbar Administration was not operated in this manner, owing to the very complicated nature of the train movements and the expense that would have been entailed in interlocking the diagram with the table. Instead of so doing, separate diagram operators were appointed to manipulate the discs, above described, by hand, and to enable them to do so with accuracy and certainty they were equipped with cap telephone receivers the leads of which were taken direct to the terminals of the Controller's cap receiver, and thus made it possible for the diagram operators to ascertain at the same moment as the Controller what each station operator reported.

The operation of this diagram, 10′ by 4′ in dimensions, at Delhi was a constant source of interest and amusement to the unemployed and gave a perfect visual indication of the state of affairs on the system at any moment.

ADDITIONAL EQUIPMENT IN CONTROL OFFICE.

The office should be big enough to allow of the Chief Controller's table being placed in a convenient position to enable him to view the line diagram.

Digitized by Google

This officer should also be provided with a telephone receiver on his table the leads of which are joined to the terminals of the Controller's receiver, so that at any time he desires to do so he can ascertain first-hand what is transpiring on the line.

He will also require to be provided with telephones connecting with other offices, *e.g.* District Superintendent, Station Master, Loco. Foreman, etc.

It was found desirable at Delhi to issue to the Chief Controller daily a graphic of the train service for the next day; this graphic was placed in a prominent position on his table, and by its means he was enabled to plan out the movements and issue general instructions to the Controller, when the latter came on duty.

The blank train slips should be kept under lock and key in the Chief Controller's possession, and it is his duty to take over all the completed slips at the end of a day's work and bring to the notice of the District Superintendent any matters requiring attention.

In short the Chief Controller is the fountain head of all information in regard to the train service, and he is most favourably situated for giving advice as to requisite alterations and additions in a time-table.

Equipment of Operators' Offices.

Operators as a rule should do their work standing; they must be constantly moving either to reach a telephone or to see for themselves whether their instructions are being carried out in the local yard. A high narrow desk is therefore necessary to carry their registers, so that they can fill in the entries without sitting down. The Control telephone and those joining up with the operators at the stations on each side should be fixed immediately over this desk and within easy reach for a tall man; if the operator happens to be short in stature a small movable platform should be provided for his use. If telephones exist connecting the operator with the signal boxes or auxiliary lever frames in the yard they also must be grouped with the Control 'phone in as convenient a position as possible.

Location of Operators' Offices.

The location of the operator's office is a matter of some difficulty and must largely depend on the size and shape of the yard. It is very important that the operator should be in close touch with the station master; if the latter has control of the shunting in the yard and the points and signal staff are under his orders, a very complete system of interchange of information between the two must be devised. Even so there is a probability of divided responsibility and it is without any question better to make the operator responsible for all movement into, out of and within the yard, in short for all train working, while the station master's duties are

Digitized by Google

confined to the issuing and collection of tickets, booking and delivery of goods, parcels and luggage, the upkeep and preparation of the necessary records and returns and the interior economy of the station and correspondence in connection therewith. If the work is divided in this way there are three different kinds of stations the location of the operator's office at which has to be considered. To take the simplest first, namely that of an interlocked or non-interlocked roadside station the signals of which are lowered from a frame on the platform, no signal boxes or cabins being provided; the operator's office should then be situated in the station building as near the lever frame as possible. Next is the case of a moderate-sized interlocked roadside station with a control cabin at one end and a lever frame or subsidiary cabin at the other; here the operator should also be located in an office on the station platform in a central position for viewing the condition of the yard and of the signals giving access to or exit from it, but it is most necessary that he should under these circumstances control the actions of the cabin men in the matter of lowering signals by means of a Hepper's key transmitter or some similar device. If this electrical control is considered too costly, the alternative seems to be to place the operator in the main cabin and arrange for him to interchange information with the station master by telephone messages accompanied by private codes or numbers.

Lastly comes the case of a big yard with two or more cabins where the operator should be placed in a central position in close touch with the station or yard master, and control the cabins by means of an electrical key transmitter.

It should again be repeated that a division of duties whereby the operator is only responsible for the movement of trains between stations, and the station master for that within the yard itself is not satisfactory however carefully thought out may be the methods of interchange of information between them. This division was adopted on the Delhi Durbar Railway, but there was friction between the two men owing to the station master being in most cases the senior in the service and resenting orders for train movement emanating from his junior. This trouble was only obviated by the operators prefacing their instructions to station masters by the words "Chief Controller orders that . . ."

PROCEDURE IN CASE CONTROL TELEPHONE BREAKS DOWN.

In all traffic operation one of the greatest sources of confusion, and even of danger, is the temporary suspension, owing to a fault in or failure of the apparatus used, of a recognized method of train movement, whether by means of an electrical token or by ordinary written "authority to proceed." In the case of the A.B.C. system it is laid

Digitized by Google

down that no train is to be sent on without an order from the Controller. But suppose the Control telephone breaks down, what then? The answer is that the operators shall carry on without the Control orders, and give and receive "line clear" as before, taking upon themselves the responsibility for precedence, which is under normal conditions vested in the Controller, in addition to that for safety which they always had. This does not involve a "change" in procedure, such as that from "Tyers' Tablet" to written "line clear," or electric staff to pilot working, and it is in "change" that the danger lies, as all railway men know. In order to obviate confusion and delay it is necessary to convey by some rapid means to operators the information that the Control telephone has broken down, and this can be done by ordinary Morse telegraph, the provision of which at all stations on the division is essential not only to meet situations such as that under consideration but also for the transaction of ordinary railway business. A code word meaning "Control 'phone out of order, carry on without Control," and accompanied by a private code from the Controller is all that is necessary to send by telegraph to the station or stations with which telephone connection is broken.

Much useful experience of the adequacy of this arrangement was obtained during the operation of the Delhi Durbar Railway, where in the early days of its installation the telephone apparatus was constantly breaking down, and although some small delays occurred, as they are bound to occur no matter what procedure is adopted, no serious confusion or semblance of an accident was ever occasioned.

Similarly when the telephone between two operators fails, recourse can at once be had to "the station-to-station" Morse telegraph, which provide a necessary alternative on a busy section.

Importance of the Operator being on his Telephone without a Break.

It cannot be gainsaid that if the man in charge of the train working is compelled for any reason to absent himself from his instruments in order to perform other duties, the train service must sooner or later suffer. In English working the cabin signalman never leaves his box during his tour of duty, except to hand up the "token" to a driver, but in India the station master on duty not only has to attend to the "line clear" working of a small station, but as often as not he is also required to issue and collect tickets, answer passengers' enquiries, book and deliver parcels, luggage and goods, all or any of which will take him out of call of his Morse instrument.

That any system of working a heavy traffic shall have a fair chance of success it is imperative that the duties of operators at stations, whether they be called station masters or signalmen, shall be con-

Digitized by Google

fined to train working and train working only. This applies more particularly to the A.B.C. system, inasmuch as the Controller in order to plan the movements must continually require information from the operators at distant points and the absence of one of them from his telephone may seriously detract from the completeness of the Controller's information and consequently to a greater or less extent spoil his schemes.

The busier the division the more truth there is in this statement. During the operation of the lines controlled by the Delhi Durbar Railway, the operator in one of the cabins was called upon to leave his office and for a few days hand up a written permission to drivers to pass a defective signal at danger; the traffic was not at its height but was sufficiently dense to cause this short absence from the telephone to be a serious handicap to the Controller.

The A.B.C. system of operation will not be resorted to unless traffic is very heavy, and it therefore follows that the operators' duties must be limited to train movement only, and if there is any outside work such as handing up "permission to proceed or written orders" to drivers it is a question for careful consideration whether operators should not be given the assistance of menials, such as levermen or peons.

MAXIMUM NUMBER OF TRAINS WHICH CAN BE HANDLED SIMULTANEOUSLY BY THE CONTROLLER.

The experience gained on the Durbar Railway went to show that the greatest number of train slips which the Controller could deal with single-handed at one time, irrespective of direction, was 17. As many as 22 were on the table simultaneously, but it was then necessary to have two Controllers at work, one operating the exchange and telephones and the other maintaining the written record. It must be remembered, however, that the line was double and the average distance apart of stations was only 1½ miles, several signal boxes being as close as a quarter of a mile to those on either side.

If the stations had been an average distance of 3 miles apart, the Controller could theoretically have handled twice as many trains simultaneously, in absolute Block working, as he actually did with stations 1½ miles apart.

On the double line trains in opposite directions do not impede one another, being allotted separate running tracks, but on the single line two opposing trains cannot be on the same section at the same moment, and by the same process of reasoning the Controller could on the single line with stations 3 miles apart simultaneously handle four times the number of train slips which were the limit of his capacity under Durbar Railway conditions.

Digitized by Google

The matter need not, however, be laboured further, for it is abundantly clear that the Controllers on the Durbar Railway were tried far more highly than is ever possible on an ordinary single line, where it may be assumed that stations will rarely be closer than 4 miles apart which is the same thing as saying that the maximum number of sections on a 100-mile division will not exceed 25.

It may be laid down with confidence that the maximum number of trains which will be running simultaneously in one or the other direction on a single line division of 100 miles under exceptional conditions will not exceed 25, a total which the Controller should be able to handle without embarrassment.

Controller's Chief Difficulty.

The arrangements for precedence and crossing of trains at roadside stations on a single line will not be found to cause the Controller much anxiety; the most harassing part of his work is the movement into, in and out of the various junctions and terminal yards of his division. There must be some point at which his responsibility for the precedence of trains commences and if the movement within the limits of, and into and out of both ends of, the junctions and terminals is outside the jurisdiction of the control, trains will be brought into or depart from these yards in accordance with what is locally convenient and without consideration for the general effect on the traffic on the division controlled; to obviate such short-sighted methods is precisely why the system of a central directing agency will have been established. As a case in point may be quoted the incessant difficulty of moving trains into and out of the yards at Delhi Main and Delhi Sadr during the Durbar. Up to a certain point the staff at those stations were perfectly willing, nay anxious, to fall in with the Durbar Railway Controller's desires, but they were not under his orders, and when it was considered locally convenient to execute movements other than those proposed by him, his wishes were disregarded. The result was that the Controller's schemes were repeatedly nullified, and if the system of working had not been extraordinarily elastic, and the station-to-station distances comparatively short, confusion must inevitably have been experienced. For example the Controller would ask if Delhi Main could receive a goods train which was ready to start from the Shakurpur sorting yard; the reply was "Yes, send her along." The train was accordingly started, and although the run was only 25 minutes, as often as not Delhi would hold the train up at signals and thus block the main line, because it was in the meantime discovered to be necessary to execute shunting on a passenger train in the main yard and so block the entrance. There was a want of some central authority to direct the whole movement not only in the junction, but immediately adjacent

Digitized by Google

to it on both sides, and if this central authority can be placed in full possession of information as to the whereabouts of every train and the work required to be done in connection with it, he must necessarily be in a far better position to judge what shall be done and when it shall be done than the station master, even of a big junction, who can only deal with the situation within his station limits. The obvious deduction, therefore, is that, when a system of central control is established on a division between two engine-changing stations, the movement of running trains, within the limits of these stations and of any intermediate junctions, must be under the direct orders of the controlling authority and not only that, but the jurisdiction of this authority must extend to the arrivals and departures of all trains into and out of both ends of these yards.

TELEPHONE WORKING.

The idea that the telephone is an unsafe instrument for train working is deep rooted in the minds of many experienced railway men; in America on the other hand this idea is daily losing weight, and the Morse instrument is rapidly being superseded where traffic has become exceedingly dense. It should be hastily added here that the many serious accidents which have occurred of recent years in that country can in no case be attributed to telephone working but to some other weakness in the system adopted, in most cases a failure of the human element. It is proposed to adopt the telephone for train working under the A.B.C. system chiefly because of its convenience in the matter of *interchange* of information between Controller and operators, and because it is undeniably less tiring to manipulate for lengthened periods than the Morse telegraph.

The experience gained during the Delhi Durbar must again be brought forward. The total number of trains handled in 40 working days was 8,479, and eliminating the seven hours daily during which traffic was infinitesimal the average for the remaining 17 amounted to no less than 11·52 trains per hour. The greatest number of trains handled in a 24-hour day was 256, and the greatest strain was thrown on the control on two occasions when 73 and 75 complete trains were handled in a period of two hours on each date. That the strain could have been successfully borne with the Morse telegraph as the only means of communication is unbelievable, and yet not a single accident of any sort in the movement of trains was experienced.

It is stated also that the native of India is not adapted to conversation on a telephone; every native of India is certainly not born to be a successful telephone operator, any more than any Englishman can easily acquire the art of so conversing in Russian or even in Hindustani, but he can be taught. A curious case came under the

Digitized by Google

writer's notice at Delhi; on one occasion an officer happened to be in one of the signal boxes, and heard the assistant station master making a series of curious sounds into the trumpet of a telephone; these sounds were a series of short and long clicks made with the tongue thus:—Click...click, click, pause, click, click, click...pause, click...click...pause, click, click...click, etc. It sounded most absurd and uncanny, but on the performer explaining that he was reproducing the Morse code, so that the man at the other end could understand, the mystery was unravelled. Further it transpired that the man at the other end could understand clearly what was said to him on the 'phone, but his conservative instincts were such that he would not accept spoken messages, unless they were spelt out in the way he was accustomed to receive them, namely by the Morse alphabet! The fact was he had never been taught to use the telephone, and naturally looked upon it with grave suspicion, as an instrument which was bound to get him into trouble sooner or later.

Some maintain that any inexperienced person can speak through a telephone in a clear intelligible manner; this is not so, even intelligent men require to be shown how to use it. If one hundredth part of the time considered necessary to make an efficient telegrapher were devoted to the training of men in the use of the telephone there is no reason why the latter should not be a perfectly adequate apparatus for train signalling and operation.

The training of a telegraph signaller is a lengthy and difficult business in India, and the results leave much to be desired. The value of telephone operation is undeniable, apart from its association with the A.B.C. system of working, inasmuch as a very short training is sufficient to make a good operator, provided he is the right class of man to start with. If telephones were more universally installed on the main lines and normally used for giving and receiving the authority to proceed under the Absolute Block system of working there can be no doubt that the fear of a telegraph strike would be greatly diminished. During a great military concentration also when the resources of all railways will be heavily strained, a much shorter time will be required to train new men in telephone than in Morse telegraph working, so that they can be drafted out to strengthen existing lines, or detailed to man military railways across the Frontier.

The conversation necessary for telephoning messages in connection with trains lies along well-beaten paths, and the experience of the Durbar train operation brought to light only one difficulty; this was the signalling of the private codes, consisting of a series of four letters each. It was found that some letters of the alphabet when pronounced singly sounded very much like some others and it was necessary to compile a table of letters A to Z, and their corresponding numerals

Digitized by Google

1 to 26, so that to obviate confusion owing to similiarity of sound, the distinguishing numeral could also be given when the letter was not clearly understood.

A great deal of trouble was taken to instruct Durbar railway operators in the proper tone to be used in speaking through the many telephones installed in each cabin, and without this instruction many irritating breakdowns must necessarily have been experienced.

The best way of acknowledging an important message received by telephone is to repeat it back to the source of origin, and when a very important message has been communicated, it is often desirable to insist on its repetition letter by letter; this on the face of it appears to be a laborious procedure, but the time taken is infinitesimal as compared with the repetition by Morse sounder.

One matter must be strongly insisted on, and that is that if the new system is to have fair play the whole telephone apparatus, exchange, cable, overhead line, batteries and instruments must be of a very efficient type and thoroughly well installed and maintained.

RECORD OF ORDERS.

The method of registering or recording messages is precisely the same as it is when the Morse telegraph is in use.

The Controller will maintain on the printed train slip a record of the time he gives a train order, and this order will be entered by the receiving operators in a register specially prepared for the purpose. In this register five columns only are necessary, viz. :—Date, number and description of train, time order received, the private code or number received from the Controller and any special order in connection with this train, *e.g.* restriction of speed, observance of signals, line under repairs, orders for crossing another train, and the like. Such special orders require a separate order book on the Controller's side table to enable him to number and keep a record of them as they are communicated to the line.

In conservative India, it will no doubt be considered desirable to retain the stereotyped form of line clear books for the up and down direction on the single line, and there is much to be said in favour of this procedure, if only because it causes a complete written record of train messages received to be maintained by the man responsible for the safety of movement. If this were not the case a register such as is usually adopted for double line working might be a satisfactory substitute, and with the five columns for Control orders added would obviate the maintenance of two registers instead of one.

This however is a matter for the consideration of each individual railway, and no cast-iron rules can be made to suit all alike.

Digitized by Google

Recapitulation.

It only remains to briefly summarize the various advantages which the A.B.C. system of control appears to possess over other systems of working.

With one highly-trained official in immediate touch with all stations on a division, the consequences of irresponsible action on the part of isolated station masters are eliminated, and there is no necessity to endeavour to strengthen this weak link in the chain, as is at present done, by laying down an arbitrary precedence of one train over another under all circumstances.

The presence of the Controller not only removes the tendency to slothful operation on the part of operators or station masters at outlying points, but the feeling in their minds that he is there to assist them in difficult situations is very real. Disputes between the men at adjacent stations become practically impossible, and once it is laid down that the Control record is indisputable, enquiry into delays, complaints and misdemeanours becomes an easier matter. Working at high pressure and specially selected, as he will be, the Controller's record of what has taken place is most likely to be unbiased and truthful, inasmuch as he has no time to falsify his entries, and his training would in any case prevent his desiring to do so.

There is undoubted additional safety of movement ensured under this system of working, in that not only does the movement of a train into a section outside station limits involve the co-operation of the operators at each end, but also an order from the Controller, who has a visual indication of the state of each section on the division recorded on his table and on the line diagram. In short each of these three men, who must all agree that the line is clear before allowing a train to move, act as a check upon one another, and it is hardly possible that, being situated at different places, they will all make a mistake at one and the same time.

Hardly less important than the safety aspect is the efficiency in working claimed for it; each train will be moved according as its movement will effect the working of the whole machine and not as a stray unit. The result must inevitably be that the capacity of the division, so operated, can be taken full advantage of, and trains can be pushed through or held back as may best suit the exigencies of any particular moment. It is claimed that the adoption of this system of working will cause a great saving in men, rolling stock and fuel.

That the train crew should not be kept longer on the footplate or in the brake van than a regulation number of hours is obviously of paramount importance, and with goods trains at any rate it is under the isolated station-to-station system of working by no means easy to obtain good results. Long hours are now spent unnecessarily on

Digitized by Google

the road, and a higher establishment of running staff is required to meet the traffic. Precisely similar reasoning can be applied to the number of locomotives, and coaching or goods vehicles in service; move the trains through quicker, obviate all unnecessary delays, and not only is a reduction at once made in the staff employed, and in the rolling stock equipment necessary, but also the coal statistics will show considerably better results for every mile run and ton lifted. It should not be forgotten to set off this very considerable saving against the cost of installation and maintenance of the telephone line, and of the pay of the Control Office staff.

There is much to be said, too, for the moral effect on the running staff of knowing that when they leave an engine-changing station with their train every effort will be made to get them through to destination with as little delay as possible. If drivers and guards knew that the eagle eye of the Controller watched every movement of their train during the run, and that the dilatory methods of the roadside station master, which now have such a deadening effect on the keenness of the train crews, of goods trains more especially, would be suppressed with promptness and severity, they would feel that they were to receive fair treatment, and their enthusiasm would consequently be aroused to a level impossible under existing conditions.

The new system does not require any alteration in the General Rules and Regulations for Indian Railways, being merely an amplification of the ordinary "line clear" system.

No radical change of operation is necessitated by a breakdown of the Control telephone; the regulation of the precedence of trains is temporarily removed it is true, but the actual order for the train to move, namely the "line clear" can still be obtained either by telephone or by Morse telegraph.

Occasions when the "line clear" must be cancelled will occur much more rarely than at present, owing to the fact that a "line clear" will only be asked for under orders from the Controller, whose comprehensive knowledge of the whole situation will obviate his giving an order which has a chance of being withdrawn.

Further the methods of operations by telephone are so much more rapid than by telegraph that no long period need be allowed between the time of the Control order, and the writing out of the necessary authority to proceed.

The fact that information as to a train's whereabouts can at any time be obtained for the benefit of the public or of the Superintendent is a very real advantage; a reference to the Chief Controller will at once elicit a reply without the long delay now experienced in sending and obtaining a reply to a telegram. This advantage would greatly facilitate action in case of an accident at a distance from the headquarters of a "breakdown" train.

Digitized by Google

The Controller who watches the working on his division hour by hour and day by day is in a specially favourable position to advise of necessary time-table alterations, and can after a few days' experience say precisely to what timing both "through" and "pick-up" goods trains have the best chance of a clear road.

Lastly the "Train Slips," as soon as completed, form an absolute record of the train's movements from the beginning to the end of its run, and there is no necessity to await the submission of guards' reports from a distance.

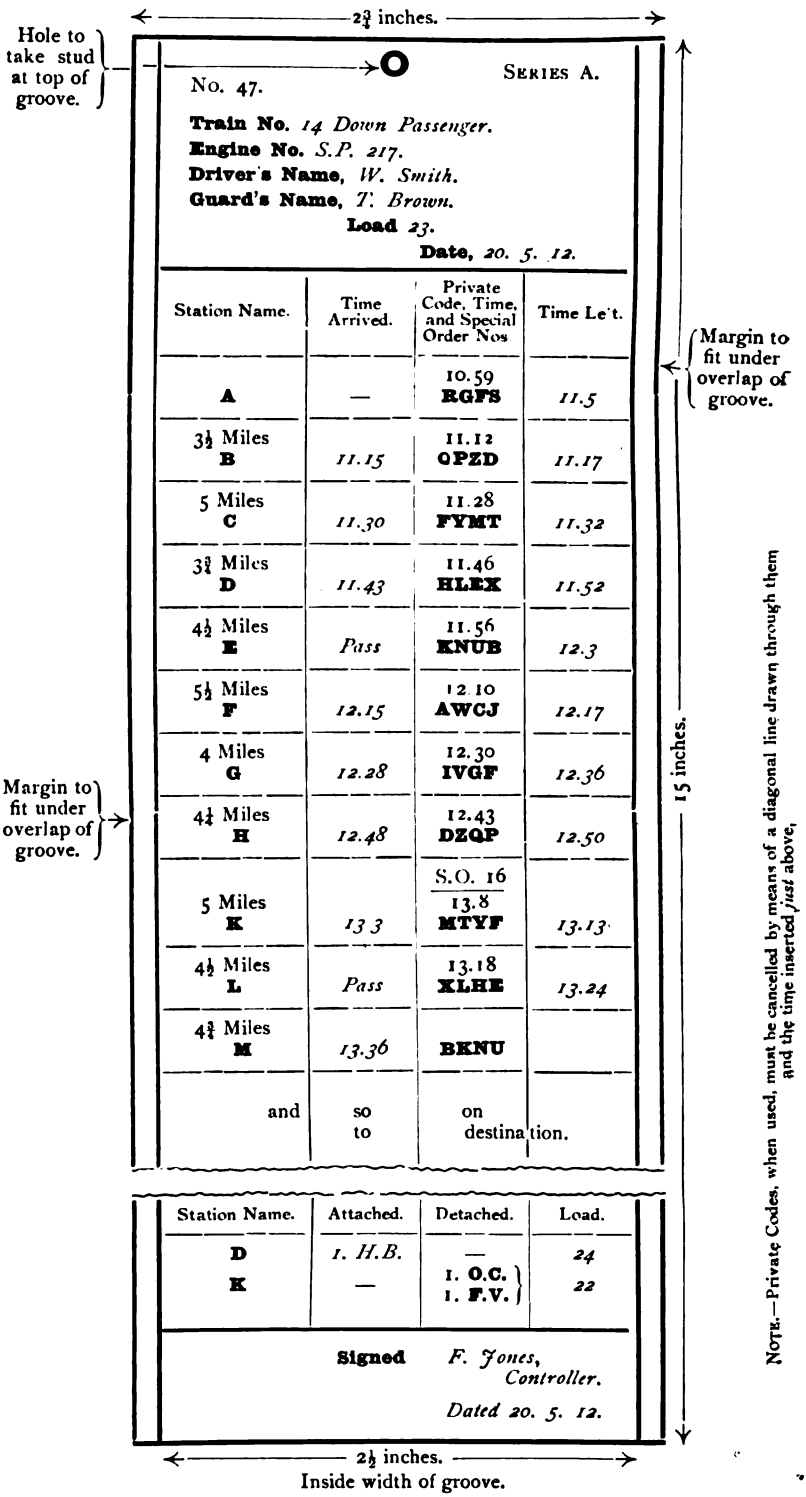
Chief Controller.

One last word on the subject of the scope of the Chief Controller's duties. On the Delhi Durbar Railway he was responsible for the training of the Control and Operating Staff, took every available opportunity for visiting the various stations and attending to the wants of the operators, received all orders in regard to the movement for the next day and instructed the Controllers accordingly, and spent most of his spare time answering enquiries and receiving orders by telephone. In addition to these various duties, which in Delhi were all-sufficient to keep the toughest man occupied, the American Chief Despatcher would be required to actually order out engines from shed for the various trains, and would, in short, take upon himself many of the duties now assumed by the station master of a big terminal yard, more especially where those duties were in connection with the work on either running trains or on trains which were made up ready to start or had terminated and were ready to break up. It is probable that the Chief Controller of an ordinary single line division of an Indian railway could take upon himself these duties also; he is not likely to be required to devote as much of his time to satisfying the inquisitive, if admiring, unemployed, as he was called upon to do at Delhi.

Digitized by Google

A.B.C. SYSTEM OF TRAIN CONTROL.

SPECIMEN OF TRAIN SLIP.


2¾ inches.
Hole to take stud at top of groove.
No. 47.
Series A.
Train No. 14 Down Passenger.
Engine No. S.P. 217.
Driver's Name, W. Smith.
Guard's Name, T. Brown.
Load 23.
Date, 20. 5. 12.
Station Name.
Time Arrived.
Private Code, Time, and Special Order Nos
Time Le't.
A — 10.59 RGFS 11.5
3½ Miles B 11.15 11.12 QPZD 11.17
5 Miles C 11.30 11.28 FYMT 11.32
3¾ Miles D 11.43 11.46 HLEX 11.52
4½ Miles E Pass 11.56 KNUB 12.3
5½ Miles F 12.15 12.10 AWCJ 12.17
4 Miles G 12.28 12.30 IVGF 12.36
Margin to fit under overlap of groove.
4¼ Miles H 12.48 12.43 DZQP 12.50
5 Miles K 13.3 S.O. 16 13.8 MTYF 13.13
4½ Miles L Pass 13.18 XLHE 13.24
4¾ Miles M 13.36 BKNU
and so on
to destination.
Margin to fit under overlap of groove.
15 inches.
Station Name.
Attached.
Detached.
Load.
D 1. H.B. — 24
K — 1. O.C. 1. F.V. 22
Signed F. Jones, Controller.
Dated 20. 5. 12.
2½ inches.
Inside width of groove.

Note.—Private Codes, when used, must be cancelled by means of a diagonal line drawn through them and the time inserted *just* above.

Digitized by Google

A LADY'S EXPERIENCES IN THE GREAT SIEGE OF GIBRALTAR (1779–83).

BEING THE DIARY FROM 1ST JUNE, 1779, TO 13TH JUNE, 1781, OF MRS. GREEN, THE WIFE OF LIEUT.-COLONEL GREEN, CHIEF ENGINEER OF GIBRALTAR (AFTERWARDS LIEUT.-GENERAL SIR WILLIAM GREEN, BART., CHIEF ENGINEER OF GREAT BRITAIN, 1786—1802). EDITED BY COLONEL E. R. KENYON, R.E.

(*Continued*).

Sund 22. Westerly Wind. Clear fine Morning. The Colonel and Child went to the Mount to Breakfast. The Setee from Algiers is safely come Round. The Enemy were at their New Work last Night. The Captain upon the Batterys did not hear them till pretty far on in the Night. He threw some Light Balls and one Shell, but the Balls were Instantly put out; either by Water or Sand. In the Morning it was Seen how Large a Quantity of Sand they had thrown up in Front of the Work. The Govr went in the Forenoon to Williss and orderd two Shells to be thrown at 10 this Night and Light Balls frequently. This forenoon a Barge with a Flag of Truce came from the Enemy. Capt Vallotton, as first Aid de Camp, went from the Govr in the Cutter to Receive the Message &c. It was a letter for the Govr. The Gun Boats have been exceedingly Bold and Impertinent all Day and at 3 oclock 4 of them came within Gun-Shott of the Shiping in the Mole &c—fir'd at the *St Fermin* Frigate and our Shiping; and at the Garrison too. We return'd their Compliment and fir'd Several Balls from 32 prs on the Kings Bastion and from South Bastion &c. One of the Shott from Kings Bastion went through the Sail of one of the Boats. They were Drove off in about half an hour and did not return any more this Evening. A Shott from one of the Gun Boats came on Shore at the Clay Pitt at South Shed. It went 5 feet Deep into the Solid Earth; the Serjant upon that Work had the Shott taken to the Kings Yard. It Weighed 26 lb (a Spanish Arrove). An other of their Shott also came against the Line Wall near the Shed where some Provisions are kept but did not do any harm. A Death at the Convent, after two months Sickness, and Buried at South Port—21 Years Old. 22nd October, 1780.

Mond 23. Westerly Wind. Fine Day. All Remained quiet last Night. The Flag of Truce was a letter to inform the Govr that Mrs Gledstanes and family were Safely arrived at Cadiz and had every Civility paid Them. More Gun Boats all Day.

Digitized by Google

24th October, 1780.

Tuesd 24. Westerly Wind. An exceeding Warm Day. Every Body wishing heartily for Rain. The Colonel up at Rock Guard and afterwards breakfasted at Williss with Captn Loyd; had an opportunity of Seeing every Manœuvre of the Enemy, as the Morning was Uncommonly Clear. This Day the Cask Fruit from on board the Danish Ship is Selling by Auction,—consisting of Raisons, Figs, and Grapes; the last Article done up in Large Bunches in Sand and in a Jarr; the Jarrs of Raisons Sold very Dear—some 8 Dollars; the Jarrs of Grapes sold at different prices. We got an exceeding Good Supply of every Article,—and a Cask of Figs. The oil was uncommonly high pric'd; the Sallad oil at 15 Dollars a Arrove, which used to be 6 and 7 Dollars, and Lamp oil for Kitchin Use, that was frequently Sold for 2 Dollars we now give 10 and a half for.

Wed 25. Westerly Wind. The Enemy have added Something to their Work last Night. We continue to throw Light Balls, and after that Shells every Night, and also Ball and Grape Shott in the Day time, but it does not Seem to affect them in the least. They are likewise Busy at a Work, seemingly a Strong one, at Caberita point,—and this Day carried away some Guns from their Artillery Park with an Intention We suppose to go to Caberita. We know to a Certainty the Enemy have 80 Mortars in their Lines and at the Camp. It is believed there are already 42 of that Sort at the Lines. I find the Boat will Certainly sail this evening for Minorca, therefore I write a letter to my Sister, as it now is Said to be the only tolerable chance We have. We Understand there is a paquet between Minorca and Leghorn. Several Jews and Inhabitants going. More Gun Boats every Day.

Thursd 26. Westerly Wind. The Boat went last Night. A very fine Day. The New Regulation of officers Provisions took place; N.B. The Beef is quite Rotten and Stinking. It seems to hurt every Body. The Troops are far from Well; and to a Certainty are very weak and greatly fallen off in their Strength and likewise in their Spirits.

Fry 27. Westerly Wind. A Cold Raw Day, looking like Rain, but it did not. I had fix'd in my Mind to go out; which I did in forenoon, went as far as Back of Grand Store. The Enemy have added considerably to the Work on this Side the Lines, and have thrown up a vast quaintity of Sand (a Parallel)— upon each Flank. The Govr has orderd Shells and every other kind of Fire to be sent, according as the officers see them, more or less employ'd. In the mean time our Garrison is very Alert in all Respects and Strengthening in a most Surprizing Way every part, which indeed Seem'd as Strong before as possible. The Number of Traverses is prodigious, and are still adding. It is realy Comfortable (as far as Such a Circumstance can possible be) to See how Much the Safety of the Troops is consulted by the Chief Engineer. The Govr and Chief Engineer Seem

Digitized by Google

wholly devoted to Care and Anxiety for the Garrison. This even very cold. 27th October, 1780.

Saturd 28. Westerly Wind. The Weather very cool; and Rain in the Evening, but very little. The Govr Here this forenoon and almost every Day. We now fire very much at the Enemys New Work. N.B. I shall make a few Remarks at the Close of this Month with Respect to this Work. A Flag of Truce was sent in a Barge this Day from Us—which was answerd by a Barge from the Orange Grove. It began to Rain at 10 at Night and continued till one.

Sund 29. Westerly Wind. A very Cold Raw Morning, and afterwards turn'd out an exceeding Wet Afternoon and Night. The Enemy have last Night and for many past ones added to the New Battery—Notwithstanding all our Firing.

Mond 30. Westerly Wind. More Work done last Night. General Boyd here in Evening having first been with Col Green to the Montague Bastion where some New Experiments were try'd,—Firing for the first time from Montague Bastion—it seemed to hurt the Enemys New Works.

Tuesd 31. Westerly Wind. Two men Deserted from their post from Upper Alls Well*,—one of the 39th the other of the 56th. The Captain at the Lines did not make a very Regular Report of that, or of our firing &c &c to the Governor. It is thought He will receive a Severe Reprimand. A Large Number of Vessels going through to the East—supposed to be a French Convoy.

At the End of this Month all Degrees of people begin to be Uneasy at the total Silence that We are cruely obliged to have with our Friends.

The Work that the Enemy began to throw up and was discovered upon the first of October was a Front Epaulment with two returns at right Angles, advanc'd upon the Isthmus, about 600 yards before their Established Lines.

On Oct 2 we in our turn Now added to our Works by making the Great Traverse on the North Bastion the Basis of the Parapet of a Cavalier for four Guns. This and Several additional Strengthenings towards the North part of the Line Wall were Laid out by the Chief Engineer.

Wed November 1. Westerly Wind,—raining and very cold. The Enemy making every addition they possibly can to their New Work on this Side the Lines. We fir'd Shells and Shott from Montague Bastion last Night and frequently in the course of this Day. A Man of the 56th deserted. It makes every Body Uneasy to find the Spirit of Dissatisfaction beginning to encrease amongst the Troops. Most of the Regts are affected, more or less, with the Scurvy. About this time we had several of the Large Tunny Fish brought In.

* This is a post above the eastward end of Princes Lines.

Digitized by Google

2nd November, 1780.

Thursd 2. Westerly Wind. Cold and Wet. The firing much the Same on our Side. We know that Some of our Shott and Shells have taken Effect, as our people upon the high Batterys frequently hear the Groans of the Enemy, and likewise We have Seen them this very Morning carrying away Several Wounded Men upon Hand Barrows. The Enemy are likewise Busy at a New Work on their own Side of the Lines, as also upon a Strong Work at Caberita point. 2 Large Ships appearing like Frigates are this Day gone over to Algezira—and are supposed to be Loaded with Stores. The following was in Garrison Orders:—"The 56th and Field Marshall Hardenbergs Regts to hold themselves in readiness to Encamp on the Shortest Notice. Upon these Regts being order'd to encamp they will assemble on the Kings Road—Hardenbergs with their Right to the Castle, and the 56th on the Left of Hardenberg's."

Fry 3. Westerly. Cold Morning. The Enemy have been very busy all Night, have made a pretty deep Track from their Barrier to the Tower near to their New Work, but it is not thought deep enough for Heavy Artillery. This morning early two Men Deserted, one of 12th the other 56th. They went off together, got round Under the Line Wall and Swam off it is Supposed, as their Cloaths were found there. This Evening the officer Commanding the Marks Men* went up to Williss and to the Head of the Kings Lines, and fir'd very frequently all Night, as did the Captain upon the higher Batterys. Also we fir'd a good Number of Shells from the *Montague*. It now is become exceedingly Uncomfortable, for as soon as it is dark the Enemy begin to Work, and of course *We* begin to Fire. Our House is just in the Line of Fire, and we are Shook by every Shott, particularly from the *Montague*—it absolutely Shakes my Bed with Violence. I believe I may add with Truth that there are hundreds keep awake beside those on Duty,—and this is the case every Night. I have not mentioned anything relating to Fresh provisions lately, as it is only to repeat the Same Unhappy Circumstances for the poorer Sort of People, some few only being able to *look* at what little Meat is kill'd,—and that now begins to be only Pork. We believe the Calves are all Kill'd,—the fish too is very Scarce. This Weather is very good for the Gardens.

A Memorandum in Orderly Book.

"When the 56th and Hardenbergs are Order'd to encamp, the 72nd to remove their people Quartered in Town into the Casemates under the Kings Bastion and Montague Bastion. 2 of the 4 Companys of the 12th Regt Quarter'd in Irish Town to be doubled on their own Corps, and the other 2 on the 39th Regt. Genl La Mottes to be doubled on the Pavilions and their own Barracks at the back of the Parade. If it shall become

* See Oct. 16.

Digitized by Google

Necessary to remove the 3 Companys of the 12th from the head of the Parade, and Captn Loyds Company of Artillery, the Company of Artillery and one Company of the 12th to be Quarter'd in the Casemates under Water Port, and the other 2 in the Nitch's of the Galley House. The officers in the first Instance to be distributed as follows :—Artillery, Engineers, 12th, 39th, Redans, and La Mottes, amongst themselves,—72nd Regt in their present Quarters. The officers of the 58th and 73rd to remove to the South, and to be Quarter'd with their own Corps. All the Hospitals to be ready to Move on the Shortest Notice." 3rd November, 1780.

Saturd 4. Westerly Wind. A great Day this in Spain, being St Carlos, the Name Day of the King. Barcelo and all the Ships at Algezira are Dress't ; and fir'd three times, as Usual on those Occasions. The Track to the New Battery was Deeper this Morning than before. We fir'd very much this Night.

Sund 5. Easterly Wind. Raining very hard at Gun Fire and at Guard Mounting. Find myself very indifferent all Day and not in good Spirits,– had a fire by desire of the Colonel in my Bed Room to Day. Much talk of the Supposed Intentions of the Enemy, as to whether they will come on or not at this time. Every Body seems Anxious to Move to the Southward. The Navy Hospital is to be taken in part for the Garrison General Hospital. Doctor Baynes has reported room enough at this Instant for 400 men, but there are Wards for 1,500,—only some are full of Stores for the Navy. Numbers of the 72nd* dieing every Day. A Meeting of the Corps of Engineers this Day, in consequence of the Orders relating to the Quartering in Case of the Enemy firing,—as all the Engineers are at present quartered on the North Side of the parade except Captn Phipps, whose Quarters are near the Bomb House. The Gun Boats were again troublesome this forenoon, as also in the Evening.

Mond 6. Westerly Wind. This forenoon the.....was at our House and unexpectedly gave a good deal of trouble and Vexation to the *Chief*. It hurt his Temper all Day, and broke In upon his Intentions. The Colonel went to the American Club, but did not Stay longer than half past 4. He then went upon business, and afterwards return'd Home alone, not over well pleased. A good deal of firing all the Evening.

Tuesd 7. Westerly Wind. The Man of the 12th who deserted on Fryday last was drove on shore near to the Convent Battery. He was directly known, and this Morning a Coat was first discover'd, behind the Rock, belonging to the 72nd Regt, with some hard pieces of Bread and cheese in the pockets,—the Coat torn all to Rags. In the forenoon upon making a Close Search, the Body of a Man Dreadfully Broke to pieces was discover'd. He had Undoubtedly belong'd

* 73rd in the other copy of the diary.

Digitized by Google

7th November, 1780.

to the 72nd as the mark upon one stocking shewed. He and 2 others got away near a Year agoe, and it was always Supposed had got clear off. The Way this Body was found makes it plain He had not been of the Lucky ones in Escaping. The Col: is but indifferent all this Day, went to the Weekly Whist Party at Capt Loyd's in the Evening. Very little firing this Day. The Enemy are doing what they think proper to their New Work, in the Day, as well as at Night—Notwithstanding our Shells &c. &c. We kill an English Sheep at this time—use it in our own family; and exchanged one Quarter as Usual with Genl Boyd. This Evening about 7 oclock there was some firing at Caberita point, and Signals made, which We believe to be in consequence of Some Vessel coming In from the West, and just afterwards a Loud Explosion was heard, and it was judged by many people that a Boat or Some Vessel, must have been blown up,—perhaps one of the Enemys Gun Boats. We continue a a good deal of firing all Night.

Wed 8. Westerly Wind. It is now Certain that it was a Gun Boat Blown up, as there was only 3 discover'd this Morning in the usual place where there has ever been 4, and We can also See an English Cutter over at Algezira. This Morning at 8 oclock, a Man of the Artillery who was Under Confinement in the Provost and had been concern'd in a Robery at Captn Martins and had turn'd Kings Evidence took an Opportunity to Settle the business by Hanging himself in the absence of the Centinel. He was quite Dead—a Young Man about 22 years old. The Enemy have added 3 Good Traverses in front of their New Work, and have Workmen now employ'd in it. Captn Lesley and Captn Falkner and Several others of the Navy Din'd with Us to Day. It is exceeding Cold, but very Clear Weather Just now. The Govr here in forenoon. A Great firing in the evening.

Thursd 9. Westerly Wind. Cold Weather. Find myself very ill. We fire a great deal during the last Night, but the Enemy advance greatly with their New Work.

Fryd 10. Westerly Wind. Cold Raw Weather. The Enemy have taken a Large Mortar from the Lines and sent it away in a Boat to Algezira. Captn Loyd upon the Batterys to Day, and at 8 in the Evening began a very heavy firing. It was at Large Working parties and Carriages. A Boat arrived this Evening from Minorca.

Saturd 11. Westerly Wind. A fine Day, rather Warmer than of Late. I went out to Dine at Col Pictons. Moderate in firing till towards Evening, and then as Usual We began to be very Brisk. It is now full Moon and We can discover all their Manœuvres. We know for a certainty that We have kill'd a great many of their mules, as we See them Lay dead on the Neutral Ground, and it is not to be doubted but We have also kill'd their men.

Sund 12. Westerly Wind, fine morning. About 7 oclock a Vessel

Digitized by Google

was observed coming over from the Barbary Coast. The Row Boats, Gun Boats, Xebeques, all got Under Sail. They Surrounded Her and fir'd frequently, She came close In towards our Batterys at Europa where she was exceedingly Well assisted. She fought with great Spirit and Judgment and as the Gun Boats advanc'd she fir'd Grape Shot. She was not able to Use more than 4 of her Guns for want of Hands. She has 8 Guns, 6 pounders, but had only 9 Hands including Boys. Two of his Men would not Stand to the Guns. The Enemy attempted to Board Her, but she pour'd In Grape Shott and also fir'd from Musquetoons, and by that Well Managed and Spirited Conduct was able to keep them off, and about 10 oclock We had the Good Fortune to get her safe into the New Mole. Great is the pleasure it affords every Body, who all strove to praise the Conduct of the Master before it was known what she was. It proves to be a *Polacre*, Captn McLorg Master, in the Employ of Mr Frazer in London, is 18 Days from Portsmouth, has Brought a most Wellcome Supply from England, consisting of Salt Beef, and Pork, Flour, Potatoes, Sugar, Butter, Porter, Cheese, Bacon, and Hams, &c, &c and a Number of News papers and Letters, but chiefly for the Merchants, who it is not to be doubted will avail themselves of the Necessity of the Garrison. The Master is a Resolute, Bold Irish Man. The Vessel is of 200 Ton Burthen ; a French Prize. What makes this Vessel more Welcome than Common is that it is the first We have had from England since the *Hyena* Frigate ; which was in April last. This *Polacre* brings word of a Grand Convoy that was getting ready with all Expedition for this Garrison,—and also that we are to have 15,000 Troops sent here. Soon after she got into the Mole the Wind came about strong to the East. This Morning also We got in an other Boat from Minorca, with Oil, Sugar, Cheese &c, &c. These two Welcome Vessels have afforded the Utmost Joy to every Individual. They may be realy call'd *God Sends*. This Evening We fire very much upon the Enemy. It is just a 12 Month since the Cutter call'd the *Buck*, Captn Fagg, came In ; the 2nd Sunday in Novbr. 12th November, 1780.

Mond 13. Easterly Wind. The Enemy have been bringing Carriages from the Lines to the New Work, and also some people are employ'd in fixing many more pickets as if intending to throw up more Works. They have also mounted some cannon upon a Fascine Battery near the Sea Side.

Tuesd 14. Westerly Wind, fine Day. An other Boat came In from the East ; last from Alicant, brings Some Useful Articles, but We had the ill luck to Lose a Setee that was coming In from Minorca. Several of the family articles which have come in the late Boats from Minorca, and also part of what came In on Sunday from England, are Selling this Day at Auction. Suppose they will go off very high ; yet we are Bless't in having them. There is but a Small quaintity of

Digitized by Google

14th November, 1780. Potatoes; and they sold at an Astonishing price. The Govr has order'd them to be sold in Small Lots, 25 lbs each, as it is chiefly Meant to have them Sow'd, which it will be time to do in two Months. They sold at three Rials 4 quarts pr lb,—equal to fifteen pence English Money! The flour sold cheaper than any other thing, owing to there being a tolerable Quaintity in Garrison. We got a Cask, near 200 Wt, 25 Drs 4 Rs. There is a good deal of flour in the Garrison We Understand; tho' it Seems chiefly kept up for the Troops and the English.

Wed 15. Westerly Wind, fine Day. The Enemy still Busy, and are forming their Boyaus of approach. It appears as if this Work was Undoubtedly intended for a Mortar Battery. It is said They have already brought some Mortars to it, but that is very Uncertain; tho' it serves to make people seem *Knowing*.

Thursd 16. Westerly Wind. Fine Cold Day. We bought a great many family Articles from the English Vessel, but all at an advanc'd and high price...as follows:—1 Teirce of Beef 85 Drs, £12; 1 Cask of Pork 68 Drs, £10; a Side of Bacon 43 Drs, £5 16s 6d; Tongues, at pr lb 1 Dr, £0 3s 6d; Hams at pr lb 6 Rials, £0 2s 6d; Butter at pr lb 5 Rials, £0 2s od; Sugar 6 Rials, £0 2s 6d; Cheese 6 Rials, £0 2s 6d; 100 Wt of Potatoes 45 Drs, £7 os od.

The Porter is 60 Dollars a Hogshead. N.B. It is impossible to avoid taking some part of these high pric'd articles. A Fore Qr of Mutton from Genl Boyd. This evening about 9 oclock 7 Gun Boats came over from Algezira and the Rivers, and fir'd at many parts of the Garrison, as well as upon our Ships. We return'd their fire from the Bastions &c. One of their shot came on Shore upon Mr Raleighs the Secry House, and drove In the Corner Stone, and Broke into a Room. It did no Material Harm but greatly alarm'd all the family. A very heavy fire was keep up until We drove them off. The Batterys also keep up a Smartt fire; but it is Supposed the Enemy are very Busy at their New Work and it is likely have sent those Boats in order to amuse the attention of the Garrison, whilst they go on, but the Captain upon the Mountain fir'd a great deal the whole time. One of the Shott from the Gun Boat hurt the Main Mast of the *Enterprize*, and the Splinters Wounded 5 Men. Also a Shot went over the Navy Hospital.

Fry 17. Westerly Wind. It is now observed that the Enemy have done a good deal of Work and are determined to go on; in the Mean time we Fire in the most Violent Way at Some Times, particularly every Night, as it is now Dark Nights, and we know they always make use of those times. They are also at a Strong Work at Caberita point; and have taken large Mortars from the Camp there.

Saturd 18. Westerly Wind, very Cold Day. The Enemy have added greatly this last Nt to their New Work in a continuation of their Line. The Governor has given the Work the Name of The

Digitized by Google

Mill Battery, it being near to an old Mill. I shall therefore call it by that Name. This Battery is about 1,000 yards from our Grand Battery. It appears as if they meant to add more to their Line ; and it is the opinion of the Chief Engineer that if they add two more Lines in a Certain Direction it will then be Evident they mean to attack Us. Captn Loyd upon the Batterys to Day and he fir'd Several Shott and one thirteen Inch Mortar which fell directly into the very Middle of the Work,—it threw them into a good deal of Confusion. This forenoon the Bed of the 13 Inch Mortar Split into a thousand pieces ; and in Consequence the Shell fell very Short. It got no further than the Gardens and burst amongst some of the Towns people who were out in those Gardens, but did not do any hurt. About half past Eight this Evening the Gun Boats came again. It obliged us to Fire upon them as Usual. In so doing a very Unfortunate Accident happen'd. A 32 pounder on the Kings Bastion Burst as it was going off,—Kill'd one Artillery Man upon the Spot—exactly took Him through the Middle of his Body, and separated his Head from his Body,—it greatly Wounded an other Gunner and Burnt a Man of the 12th Regt and Slightly Wounded Several Men who happen'd to be upon the Bastion. It was attended by many Uncommon Circumstances, amongst which was that of a very large piece of the Gun being thrown as far as a Quarter opposite the Bomb House, where Capt Phipps of the Engineers lives, and which is about Ninety Yards from the part where the Gun was mounted—this piece weighd 270 Wt.* It carried away a Water Spout and brought down a great deal of the Stones and Mortar belonging to the next Quarter. It fell into a little Sort of Garden and Sunk very deep into the Ground. It alarm'd the family greatly but did not do any hurt except Unpaving the Court Yard &c. The apron of the Gun was Blown into the Main Street, and many other pieces were found in different parts of the Town. It Broke away all the Banquet on that part of the Bastion went down to the Casemates under them. This accident has alarm'd and affected every Body. It was an exceeding bad Gun—and like too many others here—as the Remaining part was try'd with a Screw Borer the next Day. 18th November, 1780.

Sund 19. Westerly Wind ; Cold Raw Day, and every Body Seems affected by what pass'd last Night. I went out in the forenoon but was very ill and continued so all Day. All quiet from the Enemy. They carried over a Vessel that was Supposed to be such an other as that which lately arrived from England.

Mond 20. Westerly Wind and Some Rain. The Enemy very busy all last Night, and We as Usual firing.

Tuesd 21. Westerly Wind, fine Day. The Work at Caberita point going on and at the Mill Battery. The Colonel had the Whist Party at our House in the Evening.

* *i.e.* 2 cwt. 70 lbs.

Digitized by Google

22nd November, 1780.

Wed 22. Westerly Wind. All the Same. Nothing very particular. I went to Sup at Lt Col Trigges this Evening. Am still exceeding Lame, and affected by the Cold Weather, and other Uncomfortable Matters. A great deal of Firing this Evening and all Night.

Thursd 23. Westerly Wind. The Enemy more advanc'd and our firing more frequent, both by Day and Nt. The family articles which came in the *Polacre* are now Selling at Auction. We gave forty five Dollars for a 100 Wt of Potatoes for Sowing at the Mount,—equal to £7 sterling.

Fry 24. Westerly Wind, exceedingly Cold. The Enemy have added greatly to their Works and are exceedingly Bold and Daring, firing upon our Towns People, and indeed every where with Small Arms. They have been employ'd for Several Days past in Collecting a very considerable quaintity of Chandaliers, Casks, Fascines and Sand Bags; making a Depositt in the Round Tower near their Battery, and this Morning it was observed their making their Line of approach as during the foregoing Night, the Enemy have Debouched through the Lines with a Boyau of approach running from the Saillant Angle of the Well Battery, about South West, 100 feet in length. A New Method of firing was try'd from the *Montague* whilst the Govr was there about 8 oclock this Evening, at which time the Gun Boats came again and fir'd very much at the Shiping. We did not fire from the Garrison but encreased our firing from the heights. The whole Night We keep throwing Shells and Shott. Those Boats are Resolved to trouble us,—and they Effectually do So.

Saturd 25. Westerly Wind. The Colonel up upon the Mountain for Many hours this Day as well as for Several other Days, and the Govr at our House this and every Day now. I am desired to get letters ready against the Boat is expected to go which will be try'd the first Easterly Night after this. The Gun Boats came as Usual this Evening and We fir'd greatly from all parts. Several of their Shott came on Shore last Night and particularly at the Southward. Thank God, No harm as yet has happen'd from any of their Shott. This firing from these Boats is very uncertain as the Shot are often carried in a Contrary Direction.

Sund 26. Easterly Wind. Every Body Seems Busy. A Shott from a Gun Boat came last Night into the House of Mr Booth, Pratic Master. Broke thro' into the Kitchin. His House is near the Line Wall. I write to my Sister and sent it to the public packet this Day, and one to Captn Nicolls of an old Date and was meant to have gone in Septr by some Ships.

Mond 27. Westerly Wind. The Enemy greatly advanc'd in their New Work, and seem'd as if they would continue to go on; yet we are certain that every means are try'd to hinder them by our firing. They are at too great a distance as yet to Regard it so much as we wish. They are about 200 yards too far off. The Boat not gone.

Digitized by Google

Tuesd 28. Easterly Wind, very fine Day. This Boat Still here, as the plans and papers are not ready. The Colonel and Mr Holloway exceedingly busy, putting down on the plans the progress that the Enemy make every Night, and this is attended with a good deal of attention and trouble, and keeps the Colonel in a constant State of Anxiety and Business. 28th November, 1780.

Wed 29. Easterly Wind. Dull looking Day. I write a letter to my Son and send it to Mr G. Ward. The Enemy greatly advanc'd with the New Work. About this time most of their Ships are gone to the East from Algezira, and those few that remain are Closely hauled In shore. The whole House in hurry.

Thursd 30. Easterly Wind and Raining. A *Polacre* arrived this Morning, last from Algiers, is a prize taken by Mr Andersons Vessel. She brings a Number of Useful Articles, being a French Ship, Loaded with Oil, Wine, Soap, Candles, &c, &c. It is a very fortunate Circumstance, the getting In any kind of Vessel at this Juncture. More planns getting Ready. This Boat is to go to the Eastward it being impossible to get out to the West,—and the Way of Minorca Seems the only one that is any way Safe.

Fry Decr 1. Easterly Wind. A pretty good Day. The Colonel still adding to the plans, and this Morning has afforded a good deal to put In, as the Enemy have Done a good Number of feet of Work in the course of last Night. About Noon this Day a very large Ship appear'd from the East. It was at first taken for an English Frigate, but proved to be a Ship from the Levant, Loaded with Silks and other rich Commodities for England, is a Letter of Mark, Commanded by Captain Huges, 26 Guns, 70 Men. She was Surrounded by Gun Boats and other Vessels. She came into the Harbour very Safe, and we hear is to stay only to take In Water. The Grand Parade plow'd up this Day, and Such other parts of the Town as had not been plow'd up before.

Saturd 2. Easterly Wind. Raining most of the forenoon, and appears as if there would be bad Weather. The following was in Garrison Orders this Day :—"Several officers of the Garrison having Communicated observations and hints to the Governor which have proved, and others may prove very advantageous to the Kings Service; officers of every Rank are desired to Communicate any remarks which appear to them Useful. The Governor assures them such beneficial discoveries shall be publickly acknowledged at a proper time." About 6 oclock this Evening it began to Rain very Hard,—and Directly came on the most Violent Storm of Hail, Rain, and Thunder that I ever Remember; which Continued about half an hour,—and happy for this Garrison it was that it lasted no longer. As it was it has done a great deal of Harm. Several old Houses thrown down, and a vast quaintity of Rubish came from the Mountain. The whole Garrison was full of Bustle and hurry. The Colonel

Digitized by Google

2nd December, 1780.

was at the Convent* when it began and could not get away till near 9 oclock, for tho' the Violence of the Storm was only of a Short Duration, yet it continued to pour with Rain till near 11. We had continually the different Engineers coming about Drains &c. The Rain and Thunder seem'd much abatted and We were all quiet when going to Bed. The Captain upon the Mountain fir'd frequently during the Storm and all Night, as did also the officers from Prince of Oranges and Montague Bastions. It seem'd to be tolerable calm Weather when we went to Bed at 12.

Sund 3. Easterly Wind. At 6 oclock this Morning it began to Rain and Blow very Violently and Many people were fearful that it was going to be as bad as last Night. However it clear'd up. It was Showery all the Morning. The Colonel most amazingly hurried, in order to send off some papers and Despatches by the Letter of Mark which We find intends going this Night. We hear of a good deal of harm done in the New Made Gardens upon the Mountain, and at all the Grounds at the Southward. All pretty well at Mount Pleasant except that the Hail has destroy'd the Beans and Peas and the Young Salleting.† The Enemy seems rather at a Stand just now. It is supposed they are Waiting for a Supply of Fascines and Wool Bags &c, this late Wet Weather having hinder'd them a good deal. The Vessel that came In last fryday intends going away as this Evening, and in consequence the Col is exceedingly hurried in geting away his dispatches. I cannot as yet learn if it is expected that the letters which are now waiting in the post office are to be sent or not as every thing of this kind is kept a profound Secret. We have some letters at Mr Wards, which We think to send and others in the office.

Mond 4. Easterly Wind. Raining and dull Weather. The Ship did go last Night, and Captn Leslies first Lt and a Lt of Marines went Home. This Day the Colonel had a good deal of More hurry in Settling for other plans to be got Ready to go in the Boat to Minorca, which will most certainly sail the first Westerly wind. We live in a State of Earnest doubts and Expectations, which is of all Situations most distressing. The American Club Day. The Col went but came away before six oclock. It Rained all this Day and likewise at Night. We have but little Firing now. Find that the Porter which came in the last Vessel from England is already Lower'd in the price, Ten Dollars the Hogshead, and it is Supposed will be Still cheaper. We had near 500 Dollars Worth of family Articles from this Vessel.

Tuesd 5. Easterly Wind. Raining all this Day. All very quiet from Us and from the Enemy. The Whist Meeting at Lt Col Craigs. It was in Orders of the Garrison this Day :—" Lt Booth of the Corps

* *i.e.* Government House.

† *i.e.* Salad, see table under date December 30, 1780.

Digitized by Google

of Engineers is to have the Inspection, as Director, Under the Chief Engineer, of all the Mines; and all Persons employ'd therein; Taking his Orders from, and reporting to, the Chief Engineer." 5th December, 1780.

N.B. His appointment is Eight Shillings pr Day for the above Duty. It has given Universal Satisfaction; particularly to the Corps as Mr Booth is much Esteemed by Every Body.

Wed 6. Easterly Wind. A very Wet Morning and continued so all Day. About 9 this Evening the Captn upon the Batterys threw a Carcase at the Enemys New Work which shewed a good deal of that Battery, and He also followed it closely with Grape Shott. N.B. We have been very quiet of late from the Gun Boats.

Thursd 7. Easterly Wind. Still Raining and Wet Weather. The Enemy advancing every Night. This Evening a good deal of firing from the Montague Bastion, the Artillery officer upon that post being order'd to Fire a Certain Number every hour.*

Fry 8. Easterly Wind. Raining and bad Weather. The Enemy have added a Strong Traverss in front of the New Work and brought down some heavy Carriages, as it appears from the Deep Tracks in the Sand. Many of the *Knowing* Ones boldly pronounce there are already mortars in the Work—however the more *Steady* Persons say it is merely Conjecture. The Enemy have, and still continue to affect to shew great Matters; such as Seting out in View Mortar Sponges, Hand Spikes, &c, &c, &c, but all that is well Understood by this Garrison.

Saturd 9. Easterly Wind. A fine looking Day. In the forenoon an Experiment was try'd from Old Mole—to throw Shells from Howitzers to the Enemys New Battery. It answer'd very well for the most part. One Shell fell Directly in the front of their Work and threw down some Fascines, which they instantly repair'd. The officer who appear'd to command their party behav'd Remarkably Well, with much Seeming Coolness and Conduct, and Stood upon the Front Epaulment the whole time, and seem'd to encourage the Men. Our Captain upon the Batterys was expected to have fir'd upon the Enemy during their Working, but He did Not! The Govr Seem'd to express a surprize at his not firing. However it was amply made up by the Constant Fire He keep up all the Evening and Night, which it is not to be doubted did greatly hinder their Working. At half past Six in the Evening it began to Thunder, Rain, and Hail with the greatest Violence, much indeed as it did this Day Week. It alarm'd us a good deal, fearing it would be attended by the Same Unpleasant Consequences, but it did not continue more than about Ten Minutes,—after that it was a Settled Rain all Night.

Sund 10. Easterly Wind. Raining all Night and till about Noon.

* The entries for this day and the next, except as regards the weather, are transposed in the other version of the diary.

Digitized by Google

10th December, 1780. A most Welcome Sight presented this Morning. A brig from Leghorn, Loaded with Wine, Brandy, and Oil, and 3 Setees from Minorca, all get Safe into the New Mole, it being impossible for the Enemys Boats to Move from over the Way. The Brig brings flying Reports with regard to an Engagement that has been between Sir George Rodney and the French in the West Indies, in which We had been Successful, and also that the fleet was gone from Cadiz; in order it is supposed to meet the Expected fleet coming from England to this Garrison. We also hear of an Insurrection in the South America; that it was discover by means of a Priest which We had taken. The Setees from Minorca bring as Usual, many little Useful Articles but that Governor will not let them bring Live Stock.

Mond 11. Easterly Wind. Cold and Raining. The Enemy have done a good deal last Night. The Brig brings Letters with the following accounts of the Rebellion in South America. N.B. It is just the heads of a Letter which I took.

Extract of a Letter, Dated London, Septr 26th, 80.

"The *Bellona* privateer, from Buenos Ayres, brings Word the Rebellion took place in March last, commenc'd at Aregiupa; a general Revolt at Cochambamba, Oriero, Chicuto, and the other districts of Potosi, where the Kings Treasure is, and it had got as far down as Paraguay."

Tuesd 12. Easterly Wind. Cold and Rain. The Colonel not Well; did not go to the Parade. An auction of the Prize Goods. The Evening was fine. The Whist Meeting at Col Kellets. Good deal of firing this Evening and also in the forenoon, at the Enemy's being in the Gardens all Day.

Wed 13. Easterly Wind. Cold Morning. The Colonel not well. It Rained hard this forenoon and continued to do so all Day. At Night it came on very Violently and brought down still more Rubish.

Thursd 14. Easterly Wind. The Colonel better and at the Parade.

Thursd 21. Westerly Wind. This forenoon a Vessel appear'd; coming In from Under the Barbary Coast. She prov'd to be a Kings Cutter, the *Speedwell*, from Portsmouth, commanded by Lt Gibson, bringing Dispatches for the Govr, does not chuse to mention the exact time she has been from Engd, and the whole Seems to be a profound Secret. She yesterday fell In with one of the Enemies half Galleys. As the Cutter lay over near Ceuta the Enemy sent out an Arm'd Boat to see what she was, and from the manner she came In Concluded she was only a Small Vessel from Ireland, as it was formerly the Custom to send Cutters of this kind Loaded with Provisions. After the Boat had observed her a Galley came out from Ceuta and attempted to Board Her, in doing which a Spainiard fir'd a Musketoon which

Digitized by Google

greatly Wounded Lt Gibson. The Galley was drove off, having first Received a Number of Hard Knocks; and it is Suposed she was hardly able to get Into Ceuta. The Kings Cutter got Safe into the New Mole. The Lt was the only Person hurt on Board. He was Drawing his Sword at the time the Gun hurt him. 21st December, 1780.

Fry 22. Westerly Wind. Very Wet, Cold Weather. Lt Gibson is not Mortaly Wounded We hope, is brought on Shore to the Navy Hospital. It is keep a profound Secret as to what this Cutter is come out for. Therefore all Manner of Conjectures are forming. It is most Certain that it is on business of Consequence. We also Seem to Understand that a Frigate came out from England at this same time. There has not been one Single letter for any Body, for not a person on board the Cutter knew of their Destination when they were order'd at a Moments Warning to go out to sea from Spithead, and the Lt Received Positive Orders not to open his Instructions till he arrived at a Certain Latitude. This is the only Kings Vessel we have had Since the *Hyena* Frigate in April last. There is not a Man on board allow'd to come on Shore, or to answer any Questions that are Ask'd of Them.

Saturd 23. Easterly Wind, raining hard, at Day Break. A Snow arriv'd this Morning from the West, a privatter from Portsmouth, call'd the *Hannah*, Captn Venture, belonging to Mr Turnbull, She came last from Lisbon, from which Port she brings Letters dated 5th of Decbr. She has Various Articles for this place, such as Hams, Bacon, Butter, Leather, &c, &c, and a Number of letters for different Persons in the Garrison. We got Letters from our Family dated 26th October. Our Son informs Us of the Royals* being order'd for foreign service, and were at that time at Portsmouth, perhaps would embark in a week. This has afforded Us a good deal of Concern, and the More So as their destination is a total Secret. I have the happiness of hearing that all the family were well. We still remain in Ignorance both with respect to where that Regt was going; or if there is any time fix'd for a Convoy's coming out to this Garrison. This Evening the following after Garrison Orders were given out:—"There being the Strongest reasons to believe that Colonel Ross is appointed Colonel to the 72nd Regt or Royal Manchester Volunteers, altho' no official Notice has yet been received by the Governor, He is therefore only to do the Duty of Colonel in the Garrison and no longer to act Lt Col to the 39th Regt, Untill further Orders, and there being the strongest reasons to believe that Captains Baugh, and Mercier of the 39th Regt and Captain Hamilton of the 56th Regt are appointed Brevet Majors they are to do Duty as such, till further Orders.

Sund 24. Westerly Wind. A Cold Morning. Various opinions of what the Kings Cutter and this last Vessel has brought with regard

* His own regiment, which he afterwards commanded. See preface.

Digitized by Google

24th December, 1780. to News, particularly the Cutter. We hear that the *Brilliant* Frigate of 36 Guns is hourly expected, that she left England the Same time the Cutter did, being it is Supposed charged with Some public Despatches. Got a very large and fine hind Qr of Mutton from General Boyd, 22 lbs. This may be called a very Cool, Melancholy Season and much unlike what We us'd to have in this Garrison. We cannot make any great preparation for Christmas Day.

Mond 25. Westerly Wind. Christmass Day. A very fine Day indeed, and Usher'd In by a most truly Welcome Circumstance, viz., a *Polacre* from Liverpool, Loaded with flour, Butter, Hams, &c,—no less than 300 Casks of flour which is so much a greater Blessing as it now is openly known that there is not more than three Days flour for the Inhabitants in the Garrison. This Vessel may be plac'd amongst some of the *God Sends* that we have experienced since the Blockade, and has put every Body into high Spirits. The Boat is to sail this Night for Minorca by which I send several letters; and a Long one to my Sister, acknowledging the Receipt of the letters which arrived on Saturday last, and had a letter inclosed to a friend of Mr Wards, for my Son. At Noon this Day the Spainish Deserter who came In from the Enemy upon Septr 29th and who has always been suspected to be a Spy was taken hold of upon Suspicion and instantly sent Prisoner to the Provost. He was Search'd and many papers found upon Him. He has been very Closely Watched of late by Captn Uniacke of 58th whose Company is quartered upon Windmill Hill. This man went it seems, into the Soldiers Barracks there; and asked them to lend him some Sealing Wax. The Captain happen'd to be in some part of the Barrack and heard him. He directly went up to him and ask'd him what He wanted with Sealing Wax. He Directly laid hold of Him and had Him Searched. Several Suspicious papers were found upon Him, particularly a Letter, wrote in English and intended to be sent to a Colonel Nugent who has the Regt He belongs to. It acknowledges in that letter, his having Recd several sums of Money from Col Nugent and also letters. He also tells the Way that He has plan'd for his geting away. He was directly taken up to the Provost at the Moorish Castle.

Tuesd 26. Westerly Wind. A very fine day indeed. The Boat with the packet, and also an other went away last Night. I went out this forenoon and call'd upon Several and went to the South Bastion. Variety of opinions with respect to the Deserter and what will be done with Him. He has not been examined as yet. The Enemy have brought four Mortars into St Carlos Battery, as We find they have given that Name to the New Work. They are at Work this Day,—and last Night. N.B. I omitted to mention that Divine Service was performed yesterday in the inside of the Court Yard at the Convent, Round under the Colonade, and afterwards the Sacra-

Digitized by Google

ment administer'd at the Judges Court House. This is the first time that the Service has been at the Convent since the Church was made use of for a Store House. It is now full of Dry Provisions. Every Sunday the Service has been under the Kings Bastion, when ever the Weather allow'd.* 26th December, 1780.

Wed 27. Westerly Wind. A very fine Day. The Govr and the Colonel went Round to Europa and Examin'd the Boom at New Mole. We keep up a Smart firing all this Day upon the Enemys Working Partys.

Thursd 28. Westerly Wind. Rainy. A Man of 39th Regt who was confin'd in Barrack Yard for Stealing a Watch made his Escape from the Centry who had him under his charge. It is supposed he is upon the Mountain. We go to Captn Phipps in the Evening.

Fry 29. Easterly Wind. A Spainish Setee was seen off Europa and after our firing upon Her from thence the *Enterprize* Frigate sent out Boats and brought Her In, but every Body had quited Her and taken to a Small Boat. She was going to Malaga from Algezira, had a Number of letters on board, which most likely may be useful. The Setee is a very pretty Vessel and may be Worth about £150. This Day I had a Minorca Pig kill'd; which I bought in Septr last. I gave 22 Cobbs for it. It now weighs 100 Wt beside the Inside, which as pork is now sold at Six Rials a pound would amount to 75 Dollars and she cost 33 Dollars. Sent hind Qr of this Pork to Genl Boyd weight 24 lb, and a neck to Mrs Phipps.

Saturd 30. Easterly Wind. Cold Raw Day. No Comfortable preparation for the New Year. Altho the Garrison is Well Supplied with Variety of every thing except Live Stock, yet is every family Article so extravagantly Dear, that the poor sort are Dreadfully off. Three Guineas has been ask'd for a Roasting Pig, and the cheapest are sold for two. On board the Liverpool Vessel is almost every useful thing,—Corn'd Rounds of Beef, pickeld Tripe, Herrings, Bacon, Hams, and a vast Number of other articles, all to be Sold at public auction. The Rounds of Beef Sold for Seven Rials pr pound, which is equal to three shillings, and they are very Large for the most of them; a Round that was bought by Colonel Ross, 35 Dollars. I shall endeavour to set down the prices of family Necessaries at the Close of this year, and compare them with what those Necessaries were last year. It must be Remark'd that as We have been So Lucky as to get In three Vessels lately from England it has lower'd the high price of some few articles. At this time last year there was a few Oxen and Cows kill'd but that is not the case now. We have not had any Beef for many Weeks past. The last sold for 7 Rials. There has not been any Mutton for Months at the Market, nor any Goat of late.

* The other version of the diary says "upon the Kings Bastion."

Digitized by Google

30th December, 1780.

Fish has been at an astonishing price all this last year, particularly Hake Fish. We give a Cobb for what used to be only 2 Rials. Vegetables are now pretty reasonable, owing to the Number of Gardens at the Southward, and every Person is obliged to send to the public market all they do not want in their own family. A Large good Cabbage is sold for two Rials and a half (equal to a Shilling.) Upon the whole we may think ourselves very fortunately Supplied; our greatest Wants are Firing, and Wine for the Troops. The Large Supply that came some weeks agoe of Lemons has been of the Utmost Benefit to the Troops. The Scurvy is greatly abatted. The few Coals that were left on board some of the Ships which have been here many months have been sold lately. Sixteen pounds sterling pr Chauldron. Soap is cheaper than it was.

	1779.			1780.					
	D.	R.	Q.	D.	R.	Q.	£	s.	d.
Beef pr lb	0	4	0	.	.	.	0	1	9
Veal do	1	0	0	1	2	0	0	3	8
Pork do	0	6	0	0	6	0	0	2	4
Goat do	0	6	0	.	.	.	0	2	4
Turkey a piece	18	0	0	.	.	.	2	18	6
Fowls do	2	0	0	3	0	0	0	10	4
Geese do	9	0	0	6	6	0	1	1	0
Ducks do	3	0	0	3	0	0	0	10	4
Roasting Pig	.	.	.	13	4	0	2	2	0
Pigeons, a pair	1	4	0	2	0	0	0	7	0
Sausages, lb	.	.	.	1	1	0	0	3	10
Flour pr lb	0	2	0	0	1	0	0	0	4
Peas do	0	1	0	0	0	8	0	0	2
Butter do	0	6	0	0	4	0	0	1	4
Cheese do	1	0	0	0	2	8	0	1	0
Sugar do	1	0	0	0	4	8	0	1	6
Hams do	.	.	.	0	4	0	0	1	4
Candles do	0	6	0	0	2	8	0	1	0
Eggs a piece	0	0	8	0	1	0	0	0	4
Sallad oil pint (spelt Sallet in the other copy)	0	4	8	0	3	0	0	1	2
Good tea pr lb	6	0	0	5	0	0	1	4	2
Soap pr lb	0	4	0	0	2	0	0	0	8

Soap has been exceedingly Dear all this last year at pr lb 4 Rials but of late is 2 Rials.

(*To be continued*).

Digitized by Google

Digitized by Google

General Sir Alexander Taylor, G.C.B.,
Royal Engineers (Bengal).

Digitized by Google

MEMOIR.

GENERAL SIR ALEXANDER TAYLOR, G.C.B., ROYAL ENGINEERS (BENGAL).

By Col. Sir Edward Thackeray, k.c.b., v.c., late R.E. (Bengal).

In the death of General Sir Alexander Taylor, G.C.B., late President of the Royal Indian Engineering College at Cooper's Hill, which took place at his residence at Englefield Green, on Sunday, 25th February, at the age of 86, we have to deplore the loss of one of the most distinguished of the old Punjab officers trained in the school of the Lawrence's, and one who took a most important part in the Siege of Delhi during the great Indian Mutiny of 1857.

Sir Alexander Taylor belonged to a family of Scotch extraction, settled in Ireland. Among his earliest recollections were the venerable figures of his great-uncles, Major Alex Taylor, R.E. (b. 1746), Major Archibald Taylor, H.M. 81st Regt. (b. 1747), and that of his grandfather, Capt. George Taylor (b. 1748), all of whom were born near Aberdeen, and were able, strong-brained, and strong-tempered men. They were all three Commissioners of Lighting and Paving in Dublin, in the neighbourhood of which they held property.

The career of George, the youngest of these brothers, is characteristic of the family predeliction for engineering and military adventure.

He began life as a Civil Engineer at Aberdeen, where his father, Alex Taylor of Anfield, lived. Before he was thirty he had planned and superintended the construction of the Aberdeen-Inverarie Canal. He was also employed on the construction of the harbour of Howth (Dublin).

In 1776 he published, in conjunction with his friend, Mr. Skinner, a detailed survey of the Roads of Scotland ; and, in the following year, a similar survey of the Roads of Ireland.

Next year the background of his life changed suddenly. We find him in 1779 serving as a Volunteer in the British Army, fighting under Sir Henry Clinton in the United States, first at New York, and then at the successful Siege of Charlestown. His force of character and ability speedily made themselves felt ; in 1781 he was attached to the guides, and was appointed Capt. Surveyor to the Commander-in-Chief, Sir Henry Clinton. In the following year he held the same office under Sir Guy Carleton. He afterwards went to Jamaica, where he immediately received a commission as Captain in the Duke of Cumberland's local regiment.

Digitized by Google

Shortly after this he returned to Aberdeen, married his cousin, Barbara Thompson, daughter of Alex Thompson of Mount Haillee, inherited, or bought, his father's place, Anfield, was made a Free Burgess of the City, and became the Captain of the Aberdeen Volunteers.

Ten years later he left Scotland for Dublin, where he remained until his death, at the age of 88, in 1836. In conjunction with his two brothers he undertook, in addition to other charges, the management of certain high roads connecting Dublin with the South and West of Ireland.

He had three sons :—Archibald, who joined the Royal Engineers, George, who in his turn became Commissioner of Lighting and Paving in Dublin, and William, the father of the subject of this Memoir.

The profession towards which every member of this family had a natural bias was engineering; it was towards this that William Taylor turned, not so much as a scientific art, but as an instrument for promoting certain social and economic public ends which were the chief interests of the little group of Scotchmen, (his father and uncles), in the midst of which he had grown up.

Having entered into partnership with the celebrated engineer, Sir John MacNeill, he moved to London in 1833, returning to Dublin, however, after five years "exile," to devote himself to furthering the introduction into Ireland of the new steam locomotion, the use of which he confidently expected would launch his country on an era of prosperity. To the energy, tact, and enthusiasm with which he prosecuted this difficult work was largely due the rapidity with which, in spite of almost disabling difficulties, the Great Southern and South Western Railway of Ireland was opened. This railway was his passion. He worked for it *con amore* from the day when it was but a project in a few eager minds, to the day of his death in 1870.

Alex Taylor, the subject of this Memoir, was William Taylor's eldest son, and was born in Dublin in 1826.

At the age of 12, he was sent to the celebrated school at Hofwyl, near Berne, founded and personally managed by Pestalozzi's famous collaborator, Herr von Fellenberg. The foundations of this great educationalist's system were religion and altruism; the love of man being considered the natural outcome of love of a divine Creator. His own life was the embodiment of his teaching. Aiming at the production of healthy, capable, public-spirited, and god-fearing citizens, he devoted as much attention to the education of his pupils' bodies and characters, as to that of their intelligences. He trained their hands, their eyes, and their ears as carefully as he did their brains; a circumstance to which Alex Taylor owed much of his success in after life.

The practical and public-spirited bias of Herr von Fellenberg's teaching, so different to the purely scholastic system then in vogue, appealed to William Taylor; for the character and activities of his

Digitized by Google

progenitors, and his own connection with great engineering works had taught him to value all that tends to promote the civilization of a country by developing its material resources.

Alex Taylor remained at Hofwyl till he was fifteen; three years, to which he always looked back as among the happiest of his life. He rose rapidly to a position of mark in the school, more especially in bodily exercises: he was one of the best gymnasts of the place, a notable skater, a good rider, boxer, and fencer. He was also one of those selected to recite on public occasions. The moral influences to which he was subjected in Switzerland formed the man of the future.

He entered the H.E.I. Company's Military College at Addiscombe in August, 1841, and passed out in the Engineers in June, 1843. His contemporaries of the same term were the late General Charles Waterloo Hutchinson, Inspector-General of Military Works in India, Colonel Commandant, R.E.; the late Colonel Daniel George Robinson, C.B., Director-General of Indian Telegraphs; and the late Capt. George William Wright Fulton, who was killed at Lucknow during the defence of the Residency in September, 1857.*

Lieut. Taylor arrived in India in 1844, joined the Headquarters of the Sappers at Meerut in September, 1845, and was shortly afterwards sent to Ferozpore in command of a company of Sappers.

His chief amusement at Chatham had been sailing, a pastime, which, if it had militated somewhat against the attainment of the highest places in the list, now stood him in good stead; for, on the strength of his reputation as a yachtsman, he was put into temporary charge of Lord Ellenborough's flotilla of some 56 boats for military bridging, which, built in Bombay, had just made its appearance on the Sutlej.

On the outbreak of the first Sikh War (1845—1846) he had orders to sink these boats and to fall back on Ferozpore, which shortly afterwards was threatened by Tej Singh, at the head of 30,000 Sikhs, to whom General Littler could oppose 10,000 men only, chiefly Sepoys.

Although a young subaltern, Taylor was put in command of the Sappers and Miners, on whom depended the defence works of the city at this critical time. He was a member of the skeleton army, 1,000 men only, left to deceive Tej Singh, when Littler, slipping out of Ferozpur, reinforced the hardly-pressed British troops at Ferozshah (December 21st, 22nd, 1845).

After this dearly-bought victory, the Sikhs having withdrawn from

* Capt. Fulton was one of the leading spirits of the defence; active, resolute, and cheerful under all difficulties. He had been inspecting a new battery, and, lying at full length in one of the embrasures with a telescope in his hand, had turned his face, with a smile, towards his comrades, saying, "They are just going to fire," when a round-shot carried away the back of his head. His loss to the garrison was said to have been the most important after that of Sir Henry Lawrence.

Digitized by Google

the neighbourhood, he had orders to raise the boats he had sunk, which afterwards formed the bridge across which the victorious British Army marched to Lahore after the Battle of Sobraon (February 10th, 1846).

For this campaign Taylor received a medal and two clasps.

On the outbreak of hostilities at Mooltan (1848) he carried down 200 miles through the dangerous shoals and rapids of the Sutlej to the neighbourhood of Bhawalpore, in the same unwieldy boats built not for purposes of locomotion but for bridging, the heavy Engineer train required for the siege.

He served during the double siege of Mooltan under Robert Napier,* who had been his sole passenger throughout this adventurous voyage. It was during this journey that the Chief Engineer learned to know and value the qualities of the subaltern of whose promptitude and resource he availed himself largely during the siege; to whom, as will be seen, he afterwards committed the construction of the Grand Trunk Road lying between Lahore and Peshawur; and finally to whom, long years later, he offered the post of Quarter-master-General of the Bengal Army.

Alex Taylor was in charge of the Engineer's Park† throughout both sieges, and made himself a reputation both as an Engineer, and as the maker of brilliant and hazardous reconnaissances.

He guided the cavalry at the affair of Sooruj Koond (November 8th), at which engagement five guns, which had been firing for some days into Edwardes' Camp, were taken—the success of this operation being largely due to his extraordinary knowledge of the enemy's ground and positions.

When the breaches in the walls of Mooltan were completed, he was allowed by Robert Napier to act as guide to the party assaulting the left breach, a perilous honour which was not his by right of precedence. The assault was successful, but he was severely wounded.

At the decisive Battle of Goojerat (February 29th, 1849) he was Orderly Officer to General Sir John Cheape, the Chief Engineer, and had his horse disabled under him. He joined in Gilbert's pursuit of the broken enemy from Chenab to the mouth of the Khyber, and was present at the submission of the Sikhs near Rawul Pindee. After this campaign he was thanked for his services in despatches, and received a medal with two clasps.

In May, 1849, Robert Napier, the Chief Engineer of the newly

* Field Marshal Lord Napier of Magdala, G.C.B., G.C.S.I., Colonel Commandant, R.E.

† "Major Siddons, R.E., the historian of the Siege," writes Sir Herbert Edwardes, "makes justly honourable mention of Lieut. A. Taylor, the officer in charge of the Engineer's Park, who, with a singular zeal and ingenuity prepared all kinds of contrivances for facilitating Siege operations, making his Park quite a show."—H. Edwardes. *A Year in the Panjab*, II., 537.

Digitized by Google

annexed Panjab, entrusted him with the construction of a new military road destined to connect Lahore and Peshawur :—a distance of 290 miles. This great work had to be commenced, *ab initio;* the country was wild and unsurveyed; no regular roads existed; no maps; no machinery; and no organized body of labour, skilled or otherwise. The Lahore-Peshawur Road is now the first military road in India, and in its extent, and in the dimensions of its bridges can be compared only with the grand military roads over the passes leading from Italy to Switzerland. The first project was to open a main line of trunk road from Delhi to Peshawur. The viaducts over the Five Rivers were to be postponed, but the bridges of all the lesser streams were to be undertaken, and a good passage made through the rugged region between the Jhelum and the Indus. The roadmakers under Lieut. Taylor immediately grappled with all the engineering difficulties over the whole length of this extensive line, connecting most of the important stations of the province with each other, and with the other provinces of India. From this trunk line there radiated branches in every direction; the most noteworthy of which was the road from Lahore, the capital, leading southwards to Mooltan and immediately connecting the Punjab with Sind. Taylor worked unremittingly on this road from 1849 to 1857.

The young roadmaker, with the experience and lessons of Mooltan fresh in his mind, joined the force before Delhi on June 27th, 1857, and was present throughout the greater part of the rest of the operations as second in command of the Engineers, under Colonel Baird Smith, the Chief Engineer.

It is unnecessary, in this short and inadequate account of Sir Alex Taylor's great services, to dwell on the so-called "controversy," of which the subject is the degree of credit for the happy issue of the Siege due respectively to Colonel Baird Smith, and to his second in command, Capt. Taylor. The subject was irksome and painful to Sir Alexander himself, who, though naturally pained by certain miscarriages of justice of which he was the victim, always begged his many friends to neither speak nor write on his behalf.

Certain letters bearing on the points in dispute have been kindly placed at my disposal by Lady Taylor. They were written by Sir Alexander Taylor, under the pressure of circumstances and in reply to direct questions, to Sir John Kaye, after the publication of his history of the Mutiny. As they will probably be published shortly, in their entirety, the quotations made from them here will be confined to passages containing technical matter relating to the Siege, which may be of use to Engineer officers engaged in siege warfare.

Before giving these extracts I would call the reader's attention to a short note by Sir Frederick Maunsell on this group of letters, a note which I publish with his permission. It bears witness to Alex Taylor's chivalrous and self-sacrificing nature, and runs :—"Sir Alex

Digitized by Google

Taylor's letters give the best evidence concerning his action and work in the Siege. I knew him first at Mooltan, and afterwards at Delhi. These defensive replies were forced from him by those who demanded the facts from him directly. Never was he one to claim more than his due. At Delhi he simply did as a duty, what was laid on him, and humbly let others . . . take the credit and honour really due to him."

The following extracts are taken from a letter to Sir John Kaye dated November 29th, 1875, in which Alex Taylor describes the manner in which the plan of attack was gradually evolved.

"It will be convenient," he writes, "to consider separately the time we were on the defensive, and that during which we were the assailants. During the first period the engineering works were as compared with the second, on a smaller scale. Our general routine was the following:—The work to be done to-morrow was decided upon to-day, generally on my return to camp in the evening; but, sometimes, on the report of the Engineer officers who came off duty; or on the requisition of an officer commanding a post. The detailed orders, when drawn up, were placed on record, and issued. Anything emergent was dealt with on the spot, generally by me, and reported to Baird Smith on my return to camp. This arrangement worked excellently. I do not remember meeting any difficulty in having what I wished done,—'put in orders,'—or that I was ever directed to carry out what I did not approve of.

"But beside the current work there was the big question ever present:—'How is the attack eventually to be made?' I often talked the matter over with Baird Smith. We both agreed as to the front which was to be attacked; and it was also clear to us both of what immense value *time* would be when once we had taken such a step as would disclose our intention to the enemy.

"An attack in full form, with trenches, etc., was clearly out of the question. We could not hope to have the men for it . . .

"Before a project could be framed which involved the formation of a breach it must be clearly ascertained that the walls could be seen from a distance so low down as to admit of their being breached. If they could not be thus seen, then an attack of this kind would be impracticable.

"Again, in a race against time it was evidently necessary that the proposals, whatever they might be, should have been critically examined beforehand *on the very ground*. There must be no question as to whether the objects to be fired at by the different batteries proposed would be visible from the sites intended for the aforesaid batteries. There must be no room for error . . .

"The ground we purposed to operate on had been in the hands of the enemy since May; and part of it at that time was studded with large buildings and trees. What had the enemy done? Had he levelled the Custom House? The Khoodsia Bagh? Ludlow Castle? Had he fortified them? Did he occupy them in force? A time project could be prepared only when all these questions could be answered with certainty . . .

"The first thing to be done was to get on to the ground on which our

Digitized by Google

work would lie. But how to do it? It had long been in the enemy's hands, and he had a large piquet of perhaps a regiment in Ludlow Castle. But we wished, carefully, to avoid alarming him in this direction; it would not do therefore to ask the General to drive in this piquet; nor, even if this were done, were we likely then by open force, to be able to carefully examine the ground we wanted:—to get into the Khoodsia Bagh, and to examine the Custom House, and the ground round it, lying close, as they all did, to the ramparts. The prospect was not encouraging.

"Watching Ludlow Castle, however, one day from the Ridge, it seemed to me that the old piquet had been vacated, and that the new one had not arrived. I thought I had now a chance of examining the ground personally. Disencumbering myself of my sword, and armed with a pistol only, I took a party of 16 men from a piquet of the 'Guides' and advancing from Metcalfe's piquet passed between Ludlow Castle and the river, and reached the Khoodsia Bagh. Leaving the men in extended order outside, with strict orders on no account to fire, I entered the enclosure with the havildar, and explored it thoroughly; then, mounting on the wall next the city, I could see the sentry on the ramparts, seemingly so close, that it was difficult not to think that he *must* hear the noise my climbing unavoidably made. The Custom House, 180 yards from him lay immediately in front of me, and for more than an hour, lying on my face on the top of the wall, behind a small shrub, I carefully examined it, and the ground around it. Finally, after a stay in the Khoodsia Bagh of about two hours, we effected our retreat without having been observed.

"This work was of course of extreme risk and danger. We knew that our left flank was safe, as it rested on the river; but, obliged as we were to keep ourselves strictly in the dense cultivation,—chiefly groves of orange-bushes,—we could not know what was happening on our right; and, with the enemy's piquet-house between us and our nearest post,—more than a mile off,—escape would be hopeless should we be discovered.

"I learned on this occasion that the roof of the Custom House had been burnt, and had fallen in, but, that the brick walls remained standing (this was eventually the site of Battery No. 3); that the ramparts could not be breached from the Khoodsia Bagh; that neither the latter place, nor the Custom House were, or had been, occupied by the enemy, the vegetation around them being fresh and untrampled; and that the only place in the vicinity outside the walls which was occupied in force was Ludlow Castle.

"Other opportunities similar in character seemed to offer at intervals throughout the operations in July, August and September; and I always tried to take advantage of them, though not always with success. Sometimes we stumbled upon the enemy, and had to fall back.

"On one occasion, when far in front of our most advanced posts, we were allowed to march to within 60 yards of a low stone wall which crossed our path at right angles,—myself and twenty men,—when suddenly a couple of hundred men,—who seeing us coming concealed themselves behind it,—sprang up; delivered a volley in our faces; and jumping over the wall, tried to close with us. After a little hesitation, we turned, and took to our heels, with a lead of perhaps 30 yards (fortunately in the hurry and excitement the fire had been bad, and only one of our men had

Digitized by Google

been touched,—grazed in the knee, but not crippled), and after an exciting race of more than half a mile I should say, we escaped uninjured into Metcalfe's piquet.

"On another occasion, Ludlow Castle seeming to be unoccupied, and an escort not being readily procurable, I made my way to it alone, and was using my eyes from the *top of its roof*, when the head of a regiment appeared; I saw it entering the gateway, literally only a few yards off; I succeeded in getting downstairs; out at a door on the other side of the house; and over the garden wall; fortunately without having been observed.

"On most of these explorations I was not accompanied by any officer. The work was of a very dangerous and risky kind, and lives in those days were very valuable. But Greathed, I remember, was with me on one of my failures; and Lieut. Thomason, R.E., on another day, when we succeeded in getting into the Khoodsia Bagh.

"In this laborious way I was able to mature a project which would bear scrutiny.

"The breaching batteries were placed where alone they could be successful, *i.e.* on the prolongation of the right flank of the Cashmere Bastion.

"The other batteries were all placed where their guns could clearly see to do the duty assigned to them.

"The Khoodsia Bagh, which still remained unoccupied by the enemy, and unimpaired, provided a secure and well-sheltered post close to the ramparts, for the troops required to protect the advanced battery, No. 3.

"Ludlow Castle similarly afforded a good cover for the guard to protect the breaching battery, No. 2.

"Battery No. 1 would not only silence the Moree Bastion, but would also close the open plain between that Bastion and the Ridge against a sortie in force; it would also prevent a similar sortie being made through the Cashmere Gate.

"Every one of these points I made sure of in broad daylight. There was no room for error.

"This project I unfolded to Baird Smith from time to time as the different facts on which it rested became established.

"When laid, by the Chief Engineer, before General Wilson, the latter doubted,—I learnt this from General Nicholson,—that I could possibly have visited Ludlow Castle, and the Khoodsia Bagh, and he questioned the information I gave concerning them; to which, however, he attached so much importance, that General Nicholson undertook to go to them under my guidance, and to report the result. Accordingly I took him at midnight into Ludlow Castle, which we had the extraordinary good fortune to find unoccupied; then, to the Khoodsia Bagh; and finally got him safely back to camp.

"Of the nature of his report I can have no doubt, and I never afterwards heard of any objections to my project.

"We now come to the execution of the attack. The project was strictly adhered to. Our only trouble was with the old brick walls of the Custom House at Battery No. 3. These caused more trouble than we expected, and the battery took longer to construct than we anticipated. . .

Digitized by Google

"Early in the Siege some delay occurred in searching for the Officer Commanding in the trenches for the purpose of having certain orders issued (the importance of *time* at this juncture must be remembered). General Nicholson, hearing of this, afterwards passed *every* day—I think—of the Siege with me on the works, in order to give me the benefit of the weight of his authority. He was also in constant communication with Baird Smith on siege questions both before the attack and during it. We certainly all worked together with the greatest harmony."

In another letter Alex Taylor refers again to the excellent relations which obtained between him and General Nicholson during the operation preceding the assault. He describes himself as "on the Works every day, from an hour before dawn till sunset, with General Nicholson beside me for nearly the whole of the time;—any movement of the troops I wanted effected, he at once arranged for; the rapidity of action, which, under the circumstances, was of such importance, was thus secured."

The following extracts are taken from a series of notes made by Alex Taylor in November, 1875, on one of his own reports, unexpectedly put into his hands by Sir John Kaye. This report deals with events subsequent to the Assault; it records the movements made by his orders on September 18th, and illustrates the unusual independence of action accorded him on account of the circumstance that his chief was incapacitated by sickness from active work.

It records *four* steps taken by him on September 18th:—

"Nicholson had lost his life in attempting to carry Burn Bastion," so this note runs, "the attempt had been renewed under Colonel Greathed, and had again been unsuccessful. The aspect of affairs was gloomy. Under these surroundings the Officer Commanding on the spot, on my personal application to him, placed a large body of men at the disposal of Lieut. Geneste (the Engineer Officer on duty at the spot) to enable him to make a further attempt.

"In the centre I had had the large block of houses, between the workshops and the Begum's gardens, occupied by our men. I had seen that the enemy held this block of buildings weakly. We had just experienced a very serious repulse on the right, which would give him confidence, and we might soon expect a hot time, during which any advance would be difficult. The opportunity that now offered should not be lost. I applied therefore at once to the Officer Commanding on the spot to have the 'block' occupied before the conditions should change to our disadvantage. He complied with my recommendation. Wilde's regiment was moved forward, and took possession.

"I announced my intention to move the detachment then in the Magazine up to the Canal.

"With regard to the occupation next day of the Sahiba Mehal; I would have to examine the ground once more, and have it occupied, or not, as I thought best. I well knew that Baird Smith would not make any objection to what I wanted done. I had by far the best means of judging, and he *quite knew it.*

Digitized by Google

"This report clearly shows that I did not feel I required any support from Headquarters to enable me to carry out on the spot any work or movement of the troops likely in my judgment to become desirable. I was satisfied that I had sufficient influence with the Officer Commanding. I would also say that the General in giving me authority next day to attempt to carry the Burn Bastion, after the previous failure with the troops, who detested street fighting, gave a strong proof of his confidence in my judgment."

The following is Sir John Kaye's lucid account of the events of the same day, and of that following:—"Ever to the front, ever active, ever fertile in resources, the Engineer Brigade had much work to do, and did it well in this conjuncture. It had been terribly shattered during the assault. One after another, the subalterns attached to the different columns had fallen beneath the fire of the enemy. Few had escaped the perils to which they had been exposed.* But happily Alexander Taylor was alive, though not unhurt, as a bullet had struck him painfully on the chest on the morning of the assault. And there was work for his active brain in devising the best means of securing what we had gained, and in superintending their execution. All the professional resources of 'those who were left' were brought in to play, to entrench the different commanding positions, as they fell from time to time into our hands. . . .

Much had been done but the Lahore Bastion† was still in the enemy's hands. No advance had been made in that direction since Nicholson had fallen. It was evident that the appetite of our troops for street fighting had not been improved and that our attempts to gain our ends by open force must be superseded by some more insiduous method of attack. . . . So Alexander Taylor, . . . suggested at headquarters that each brigade should be ordered to work, under guidance of the Engineer officers attached to it, not *along* the open streets, but *through* the sheltered houses during the advance; using them as a means of fortification; fortifying all commanding buildings as soon as they could be secured; and placing garrisons in them. The project met with willing concurrence and consent; and Taylor and his subalterns went to their work with the thoughtful activity which had characterized all their proceedings. But the progress was not yet rapid. On the evening of the 18th they were little more advanced than in the morning. The cause was not very remote; nor was it very unintelligible. The veterans of the different brigades did not fall in very readily with the views of the Engineers, or cheerfully recognize their temporary supremacy. So situated, Taylor, with the concurrence of the Chief Engineer, went to

* At the assault on the 14th September Lieut. Tandy was killed; Lieut. Salkeld died a few days afterwards, from wounds received when blowing in the Cashmere Gate; and eight other Engineer officers were wounded.

† Or "Burn" Bastion.

Digitized by Google

the General, and drew from him an order to the Brigadier of the Kabul Gate to place at the disposal of the Field Engineer a force of some 500 men, European and Native, to carry out the above-mentioned design; and early on the 19th the advance began in earnest. This was not the least of the great services of Alex Taylor. Some 30 houses, important both by their size and position, fell into his hands, and were duly garrisoned and barricaded. Nothing could have been more satisfactory than the result. . . . Working onwards in this insiduous but most effective way, our people towards nightfall found themselves in possession of a building which so entirely commanded the Lahore Bastion, that the enemy, seeing their danger, were fain . . . to escape . . . and so the Bastion became our own! . . . Taylor reported the success of his operations." *

Alex Taylor's services at Delhi, though their full extent was known to few, were appreciated not only by those behind the scenes, but by the great mass of his brother officers in the camp. "He was one who thought nothing impossible; all men worked under him with the heartiest good-will, for he animated and inspired all who came into contact with him in battery or in trench." "The younger officers of the Engineers swore by him." "Those who were above him were equally impressed by his noble exertions":—writes Sir John Kaye, summing up the testimony of the many witnesses he had heard.

I feel I cannot bring this section of my paper to an end more fitly than by quoting the very words in which men whose commanding ability, high position, or circumstances gave weight to their verdicts, expressed their consciousness of the importance of the *rôle* played by Alex Taylor at Delhi.

Lord Lawrence, the *deus ex machina* of the Siege, wrote to Lord Dalhousie on January 14th, 1858, *i.e.*:—before the fall of Lucknow, and the complete suppression of the Mutiny:—"We have indeed had a terrible time. Up to the capture of Delhi, the scales were trembling in the balance. The Panjabis of all classes have behaved admirably, and the zeal and the courage of the Punjab troops far surpassed my hopes and expectations. Still, if Delhi had not fallen, we must have been ruined. Had the troops retreated all must have been lost.

To Nicholson, Alexander Taylor of the Engineers, and Neville Chamberlain, the real merit of our success is due.

Chamberlain was severely wounded soon after his arrival at Delhi, and, until the actual storm, was in a great measure laid on the shelf. But when our troops got inside, and Nicholson was mortally wounded, Chamberlain came again to the front, and kept up the spirits of our people, and directed the movements of the troops.

John Nicholson from the moment of his arrival was the life and the soul of the army. Before he went down he struck the only real

* Kaye. *Sepoy War*, iii., 624, 625, 626, 627, 631.

Digitized by Google

blows which the mutineers received in the Punjab, he led the assault and was the first man over the breach.

Alexander Taylor, though only the Second Engineer before Delhi, was really the officer who designed and arranged all the scientific operations which led to the success of the assault, and in the actual attack was as forward as any man that day." *

To Taylor himself he expressed himself warmly.

October 8th, 1857.

"I have to congratulate you on your success at Delhi. I look on it that you and Nicholson, poor fellow, are the real captors of Delhi; particularly after Chamberlain was wounded. I think the world also gives you credit for the part you played." †

Brigadier-General John Nicholson,—whose whole-hearted collaboration with Alex Taylor throughout the Siege proper ensured the erection of the siege works with the rapidity essential to success,—has characterized the young Engineer's services in well-known words.

"He was indignant against wrong or injury, against untruth of any kind, and knowing well the brave part that Alex Taylor took in the engineering difficulties and triumphs of the Siege, was indignant at the thought that he had not had justice done to him, and said, 'Well, if I live through this I will let the world know who took Delhi . . . that Alex Taylor did it,'" writes Lady Edwardes, quoting from Sir Herbert Edwardes' Journal.‡

General Sir Frederick Maunsell, the Engineer officer in charge of the Right Attack, and therefore of the construction of No. 1 Battery, the key of the position, writes :—"It is certain that even Nicholson's determined and magnetic leading would have been ineffectual, had it not been chiefly used to back Taylor's scientific knowledge, reconnaissances, and resolution. I was not the next senior officer to Taylor, but was one of the senior engineers at Delhi, and I can frankly state that none of us were capable of doing what Taylor did. We doubtless all thought ourselves fine fellows,—more or less,—but as to a mastery or control of the great questions and issues involved, we were nowhere as compared with him. We all believed in him as a first-rate man, and as a resourceful engineer, but it was just in the conception and grasp of the great issues, and of the means necessary to their realization, that his superiority made itself fully felt. A master of engineering detail, civil and military, and cognizant of the means

* *Life of Lord Lawrence.* Bosworth Smith. Vol. II. p. 286.

† Bosworth Smith. *Life of Lord Lawrence*, II., p. 251.

‡ Lady Edwardes. *Life of Sir Herbert Edwardes*, Vol. II., p. 62. These words were spoken in Chamberlain's tent towards the end of the siege, the late Sir Henry Daly being present. On the return of the Guides to Peshawur (1857) Sir Henry Daly reported the conversation to Sir Herbert Edwardes (who was writing a life of John Nicholson) by whom it was immediately committed to writing.

Digitized by Google

available in artillery and soldiers; untiring in bodily energy, and unsparing of himself, he, in fact, was the hero of the Siege, and the common saying:—"Taylor took Delhi," was perfectly true.

Colonel Baird Smith, the Chief Engineer, filled his place alongside the General in command most suitably. He had a *diplomatist's* duty to perform, to the success of which his knowledge of India, and his exceptional powers of speech and pen contributed immensely.

I think that the Siege of Delhi and the immense issues depending upon it were never fully appreciated. The great anxiety as to the fate of Lucknow, which filled all hearts, fixed public attention on the beleaguered garrison; while the despatch of large forces from England and Persia to its relief naturally led the home public to ascribe the salvation of India to them, and tempted it to rather ignore Delhi; yet it was the success of the Siege of Delhi which alone saved India to the British Crown. There can be no doubt of this whatever.*

In his "Notes on the Siege of Delhi," published in this Journal, the same officer writes:—"The real interest of the Siege of Delhi centres in the *heroic and hazardous way in which the scheme of attack was slowly pieced together;* and in the gallantry,—equally displayed by all,—which enabled a much-tried General to utilize to the fullest extent the inadequate means at his disposal. . . .

It seems a curious fact that the most striking feature of the Siege of Delhi has never been noted. It is surely unprecedented in warfare that not only in *the face of*, but also, almost in *the midst of* a watchful enemy, what was obviously the site for the final struggle was *completely surveyed*, and the positions of every gun; of the attacking force itself; and of all the approaches were clearly marked out on the ground, and the *action finally carried out exactly as originally planned.*"

The following statement, signed Felix†, is embodied in the "Narrative of the Campaign of the Delhi Army," officially published by Major Henry Norman, in 1858 ‡:—

"For the complete success that attended the prosecution of the Siege the chief credit is undoubtedly due to Colonel Baird Smith, the Chief Engineer, and to Capt. Taylor, the Director of the Attack. On this latter officer, in fact (in consequence of the Chief Engineer being wounded), devolved the entire superintendence of the siege works; and his energy and activity will doubtless meet with their due reward. Throughout the operations he seemed to be omnipresent, and to bear a charmed life, for he escaped without a wound. The plan of the attack was bold and skilful; the nature of the enemy we were contending with was exactly appreciated, and our plans shaped accordingly.

* "A Few Notes on the Siege of Delhi," *R.E. Journal*, July, 1911; see also "The Siege of Delhi, a Reminder from One Who was Present," *Nineteenth Century*, October, 1911, both by General Sir Frederick Maunsell, K.C.B., Colonel Commandant, R.E.

† The late Major-General Julius George Medley, C.B.

‡ The late Field Marshal Sir Henry Norman, G.C.B., G.C.M.G., Governor and Commander-in-Chief of Queensland.

Digitized by Google

Pandy* can fight well behind cover, but here he was outmanœuvred, his attention being diverted from the real point of attack, until the last, and then the cover, which might have proved such a serious obstacle to us, was seized at the right moment, without loss, and all its advantages turned against him. With plenty of skilled workmen the siege works might have been more speedily constructed; but, with the wretched means at our disposal, the wonder is that so much was done, with so little loss."

The late Major-General Thomason, who, in 1857, was one of the Engineer officers attached to the Left Attack, and consequently accompanied Alex. Taylor on more than one of his dangerous reconnaissances in the Khoodsia Bagh, and in the neighbourhood of Ludlow Castle, writes of Colonel Baird Smith as an officer "whose position as the head of a very important Government department gave him a power and influence such as was exercised by no one else"; and, as "an unrivalled administrator," adding: "In nothing was this ability better evinced than in the completeness, vigour, and steadfastness with which he backed every proposal of his second in command, Alex. Taylor."

Alex. Taylor himself pays the following tribute to the services of his chief:—"He did all that could be done by a Chief Engineer of great capacity, but crippled by heavy sickness. Indeed, he did more. He was a master of organization; took a sound view of our position, and its requirements; gave firm and wise counsel to General Wilson, more than once, at very critical times; accepted and carried an immense load of the very heaviest responsibility; and, lastly, provided the engineering means without which the work could not have been done. For all this grand work he deserved the thanks, not only of the Delhi Field Force, but of every white face to the north of Delhi, whose fate depended on our success."

NOTE.—The compiler of this short Memoir was on duty engaged on fortifying the houses and loopholing the parapets of the buildings opposite to the King's Palace throughout the night of September 20th. The enemy kept up a desultory fire.

The last stronghold was stormed by the 60th Rifles on the morning of the 21st.

Duncan Home of the Engineers, who, with Philip Salkeld, had blown in the Cashmere Gate on the day of the assault, advanced with a small party of Sappers, and blew in the outer gate.

At sunrise on the 21st we were again masters of Delhi, and the British flag waved over the Palace of the Great Mogul.

(*To be continued*).

* The name given to the rebel Sepoys from Mungul Pandy, the mutineer of the 34th Native Infantry at Barrackpore, who when the mutiny broke out in that regiment fired at the Adjutant, Capt. Baugh, and was afterwards executed.

Digitized by Google

TRANSCRIPT.

NOTES ON THE INSTRUCTIONS FOR CROSSING AND DESTRUCTION OF OBSTACLES IN FORTIFICATION (PROVISIONAL). WAR OFFICE (FRANCE). 1909.

With the kind permission of Messrs. Mare Impans et René Chapelot, 30 Rue et Passage Dauphin, Paris.

Preface.—The object of the pamphlet is to point out the technical methods to be followed, the tools to be used, and the formations to be adopted by working parties detailed to carry out, in the face of the enemy, the various works of crossing and destroying the principal obstacles in fortification, whether siege or field. It is divided into three parts:—

(i.). Crossing and destruction of the principal obstacles in the outer line of defence.
(ii.). Crossing ditches and iron fences.
(iii.). Destruction of iron fences.

The crossing and destruction of obstacles should always be planned and carried out by surprise, and generally at night time; in very rare instances these operations can be attempted in force, while the artillery fire is concentrated on a defence which infantry fire at close range has already shaken or temporarily overpowered.

It is only possible to carry out these operations successfully by employing methods which are rapid, silent, and free from complication; simplicity of method in the critical period which precedes and accompanies an assault is a quality absolutely essential; consequently amongst the many ways of crossing or destroying obstacles, there is generally only one, the most simple one, in each case, which can be considered; others may be adopted instead only if circumstances demand it.

In the pamphlet the type methods are fully described, as they should be well known to all, both N.C.O.'s and men—the other methods are shortly referred to, and should be known by N.C.O.'s and may be taught to sappers in the later stages of their training.

General Instructions.—1. The work of making a way through the obstacles is in each case carried out under the superintendence of an officer, who has under his orders one or more working parties led by N.C.O.'s. The officer and N.C.O.'s are, if possible, chosen from those who have taken part in the preliminary reconnaissances.

Digitized by Google

2. The composition of the parties, the arms and dress of the sappers detailed to carry out the work of handling the stores, depend on the nature of the task in each particular case, and the conditions under which they are carried out. The only duty of the sappers is to bring up and place in position the stores used for crossing or destroying the obstacles so as to open a passage for the assaulting troops. In some cases it may be advantageous to send out unarmed working parties so as to leave them complete freedom of movement.

If the working parties are unprotected by patrols, it may be necessary to attach a few determined men with the special object of noiselessly suppressing the enemy's sentries.

Clothing should be adapted in colour to the ground where the operation is to take place.*

Footgear should be either rubber or felt-soled, or should be bound round with cloth to muffle the movement of the feet—it may be advisable to blacken the men's hands and faces.

Stores, especially charges of explosives, should be similarly treated.

3. The method of destroying the outer line of obstacles (abatis, wire entanglement), by means of explosives, generally consists of long treble charges made up in accordance with Art. 282 and 283 of the School of Mines. These charges are generally divided into sections 5 metres long, the last of which makes up the total length required. The charges do not contain primers, in order to avoid risk of explosion during transport and placing in position. The last section has a strip of detonating fuze attached which is detonated by means of a special primer.

4. The destruction of fences is carried out by means of long charges, each about 6″ less than the width of one bay of the fence, which can be sufficiently accurately determined during the preliminary reconnaissance.

Each of the charges is provided with a length of detonating fuze about 2 metres long.

Simultaneous detonation of several bays is obtained by fixing the detonating fuzes to a detonator which is fired by means of slow fuze. This is usually done by means of a rubber ring. The detonator is carried by the N.C.O. in charge.

PART I.

CROSSING AND DESTRUCTION OF THE OUTER LINE OF OBSTACLES.

5. Passages through the obstacles should be about 12′ wide.

I. Abatis.

6. *Crossing.*—Crossing abatis is only possible by single men advancing slowly.

7. *Destruction.*—A treble charge of melinite, of a length equal to the depth of the abatis is exploded under or amongst the abatis.

* For example, white when the ground is covered with snow.

Digitized by Google

8. *Stores Required.*—The treble charge is made up in 5-metre sections, with a piece of detonating fuze fixed in the centre of each section.

The charge is fastened to wooden scantlings about 2″ × 3½″ section, the ends being constructed to fit into wrought-iron sockets. The foremost section has a wrought-iron point, and is provided with two hard-wood wheels 6″ in diameter at the front end.

9. *Personnel.*—One N.C.O., and two men for each section of charge.

10. *Method of Placing.*—The N.C.O. advances first with the detonator; on reaching the fringe of the obstacle he points out to the bearers of the front section the best spot to insert it, and they push the charge under the abatis—the second party, with the help of the first, connect the second section to the first by means of the sockets and push the whole forward: and so on till the further edge of the obstacle is reached.

The detachment then retire about 50 paces, while the N.C.O. connects the end of the detonating fuze to the detonator and lights the slow fuze. After the explosion he rejoins the assaulting column who are now approaching.

If necessary, a party of sappers precede the assaulting column armed with axes to clear away any trunks of trees not removed by the explosion.

The explosion should make a passage at least 4 metres wide. The *débris* does not fall beyond 50 metres in the direction of the charge, and 150 metres laterally.

11. *Alternative Method.*—Simultaneous explosion of several 6 or 8-lb. charges of melinite thrown by hand into the abatis.

II. Military Pits.

12. *Crossing.*—Military pits can be crossed on light ladders with planks nailed to them, lashed together.

13. *Stores Required.*—Ordinary ladders, as light as possible, and of such a length that two ladders, lashed end to end, will be long enough to stretch across the rows of pits. Planks ¼ to ½″ thick are nailed to the rungs on each side.

14. *Personnel.*—One N.C.O. and as many squads as there are ladders (usually four crossings will be made). Two men are required for each 5 or 6 metres length of ladder. Two men of each detachment carry picks in their belts.

15. *Method of Placing.*—The N.C.O. goes out ahead followed by the ladder detachments who should, if possible, reach the obstacle simultaneously. Pace is regulated by circumstances, a slow advance is sometimes less liable to discovery.

When they reach the obstacle the N.C.O. points out the places to be crossed.

Each detachment then lifts the ladder and launches it as far as possible in the air, then pushes it forward along the ground. The picks will be used to clear away any obstacle to progress.

16. *Alternative Method of Crossing.*—The stakes can be covered by throwing straw, brushwood, etc., into the pits, or the obstacle crossed by walking round the pits.

Digitized by Google

17. *Alternative Method of Destruction.*—The pits themselves on the line of crossing can be partly filled by bundles of straw brought up by men who then jump into the pits and pull down part of the sides with a pickaxe.

III. *Petits Piquets (Short Stakes).*

18. *Crossing.*—This obstacle can be crossed on ladders similar to those used for crossing military pits.

19. *Alternative Method.*—Two lines of brushwood hurdles placed with the long side of the hurdles normal to the direction of the crossing.

20. *Destruction.*—There is no practical method which can be adopted in the face of the enemy.

IV. *Wire Entanglements.*

21. *Crossing.*—Crossing a wire entanglement is only possible by single men, advancing slowly, or crawling beneath the entanglement; in the latter case the men should be supplied with wire cutters so as to cut the strands which will prevent the explosives being dragged under the obstacle

Destruction.—A. *By Explosives.*

22. (*a*).—A treble rigid charge of melinite of a length 18″ greater than the width of the entanglement should be exploded under it.

The procedure is the same as that for crossing abatis.

N.B.—It is best to place the charge along a line of posts. If the posts are steel it is desirable to explode two continuous charges about 2 metres apart.

23. After the explosion a dozen sappers with axes and wire cutters cross the gap ahead of the assaulting column to remove stray wires, etc.

24. (*b*). If there are obstacles such as planks, earth banks, etc., under the entanglement, making it impossible to use the long charges made up on scantlings, a continuous non-rigid charge is used and is dragged into position by men who crawl through the entanglement by night.

25. *Stores Required.*—Sections (5-metre) of explosive, contained in thick canvas tubes with cords sewn to them to enable them to be dragged; the sections are connected by stout threads 2 metres long.

A detonator, and a pair of wire cutters bound with cloth.

26. *Personnel.*—1 N.C.O.

One man per section of explosive with leather clothes and gloves.

27. The N.C.O. precedes the party, chooses the spot for attack, and the first man crawls with his charge under the entanglement followed by the rest, guided by the threads which join the sections. The leading man is provided with wire cutters and clears away a passage for himself. Each man places his charge so as to break joint with the preceding one.

When the charges are placed the men return by the same route.

28. *Alternative Method.*—If neither of the preceding methods can be used, rigid charges can be thrown across the entanglement, or a number of 25-lb. charges thrown into it by hand.*

* A charge placed on top of an entanglement produces only half the result of one placed beneath.

Digitized by Google

B. *By Means of Wire Cutters.*

29. A passage should be made with the wire cutters at least 4 metres wide.

This can generally only be done in the very early dawn.

30. *Stores Required.*—Seven wire cutters (cloth covered) plus twice as many wire cutters as there are rows of posts on the width of passage to be opened.

Two axes (if wood posts).

Four pairs of leather gloves.

31. *Personnel.*—1 N.C.O.
2 squads.

1st squad. Twice as many men as there are rows of posts plus two men. Each man with a pair of wire cutters hung round the neck on a lanyard. The squad is directly under the N.C.O.

2nd squad. Under a corporal carrying a pair of cutters. Four men with cutters hung round their necks, and leather gloves.

32. *Method of Procedure.*—Suppose for example the preliminary reconnaissance has shown the necessity of destroying a width of three bays, and consequently two rows of posts. The 1st squad consists of six men, and the whole detachment of 10 men plus the N.C.O. and corporal. The men of the 1st squad are told off to sever all the wires up to the posts along the line of passage; the 2nd squad have to clear all wires out of the passage, cutting those which are not broken, and clear away any posts which may have fallen across the way.

The 1st squad are placed thus by the N.C.O. in charge:—

No. 1 to the left of the right-hand post.
Nos. 2 and 3 one on each side of the next post to the left.
Nos. 4 and 5 one on each side of the next post to the left.
No. 6 to the right of the left-hand post.

The 2nd squad follow without waiting further orders.

PART II.

Crossing of Dry Ditches.

33. When a ditch is provided with a counterscarp fence, it is necessary to destroy portions of it before the materials for crossing can be placed. A crossing cannot be made until the flanking defences of the ditch have been destroyed or masked. The only two cases to be considered then are those in which the escarp is (i.) revetted or (ii.) provided with a fence at the foot of it.

Digitized by Google

Crossing a Ditch with Revetted Escarp.

34. *Stores Required.*—Long supple poles for descending into the ditch (fastened in pairs). Ordinary ladders (one per two poles) to ascend the escarp.

The length of the ladders, etc., depends on the height of the obstacle, *e.g.* not less than 7 metres for the poles (diam. 3—5″) for a counterscarp 6 metres high; the poles and ladders should have an iron point at the lower end to prevent the foot from slipping.

The poles are fastened in pairs by means of cross-pieces lashed or nailed on, one at each end, and have a cord fixed to the upper cross-piece. Ladders have a cord fixed to the upper rung.

Other stores:—4 axes, 4 picks, 2 shovels.

35. *Personnel.*—One officer and one or more detachments. Each detachment consists of as many squads as there are ladders, etc., under an N.C.O. A squad is eight men one of whom is a corporal. The eight men of the squad are in two ranks, the front rank are pole-men and the rear rank ladder-men.

A reserve squad (1 N.C.O. and 10 men with pioneers' tools) is told off to destroy any remaining obstacles which would prevent the ladders, etc., being placed, and to replace casualties.

36. *Method of Procedure.*—The officer, accompanied by detachment commanders goes ahead followed by the reserve squad; the squads advance in line or in file as rapidly as possible to the edge of the ditch, pole members in front with the corp oral of each squad. Two men carry the ladder on their shoulders. The poles are dropped into the ditch by Nos. 2 and 3 and held by No. 4 by means of the rope attached while one of the numbers fixes a pick into the ground in rear for an anchorage; to it the rope is attached.

The ladder numbers on reaching the ditch, drop the ladder alongside the poles (two men are enough for this, the other two numbers holding the rope). The ladder numbers then climb down the poles, two by two, and erect the ladder against the escarp.

37. *Action of the Storming Parties.*—The storming parties are told off in groups, and the groups arranged in pairs. Each pair starts off together and arriving at the top of the counterscarp, grasp one another round the neck or waist and slide down the poles together. The remaining numbers follow without waiting for the first pair to finish its descent.

A rate of 10 men per minute per pair of poles can be easily obtained.

II. *Crossing a Ditch with Iron Fence at the Foot of the Escarp Slope.*

38. Crossing such a ditch is carried out in a similar manner, with the substitution of special ladders (Dupommier) for crossing the iron fence.

The only respect in which the procedure differs from the last is in the actual crossing of the fence.

39. *Stores Required.*—Dupommier ladders—one for every two poles used for the descent into the ditch.

The Dupommier ladder is a light ladder 4 metres long, with a pole

Digitized by Google

2 to 3″ in diameter fastened to the right-hand side of the same length as the ladder, kept in place by an iron ring at the upper end, and by a strap in the centre. There is a right-angle bracket, free to slide along the ladder by means of four hooks.

A rope is attached to the upper rung of the ladder.

40. *Personnel.*—Two men per ladder.

41. *Method of Procedure.*—The ladder is fixed against the escarp fence as follows:—

Two men place the ladder against the fence, bracket to the rear. The bracket is placed on the points of the fence, being free to slide along the ladder, the latter can be placed at the necessary inclination.

One man then sits down with his back to the fence holding the foot of the ladder in both hands. The other unfastens the strap which secures the ladder-pole; mounts the ladder with the pole in his hands and sticks it into the ground on the far side, the top being held by the ring attached to the side of the ladder. He is then free to slide down the pole.*

42. *Action of the Storming Party.*—In crossing the Dupommier ladder, each man commences to climb as the next man steps off the ladder to slide down the pole. (A rate of 8—16 men per minute can be obtained).

43. *Note.*—Experience has shown that the crossing of a fence on the top of the counterscarp is such a difficult operation that it could not be undertaken during an assault; the only successful method of dealing with such a fence will be to destroy it by means of explosives, before the crossing of the ditch is attempted.

PART III.

Destruction of Iron Fences.

Destruction by the Aid of Explosives.

44. Operations of this nature will, usually, be carried out at night, advantage being taken of a moment when the attention of the enemy's sentries is distracted by noises such as wind, rain, etc.

45. *General Procedure.*—Usually the bays alone are attacked, the uprights being left alone.

46. *Charges.*—Treble longitudinal charges (rigid) are placed against the bars, the scantling to which they are fixed being on the outside in order to tamp the charge. If the horizontal bar is close to the bottom of the fence a non-rigid charge may be used, placed on the ground along the bottom of the fence.

47. *Mode of Fixing.*—The charge may be either fastened to a horizontal bar by means of two wire hooks, or hung by two short cords fixed to the charge—the free end being tied by a thumb-knot to one of the vertical bars. If it is desired to place the charge too high for the hooks to be fixed, or a thumb knot tied, it is supported against the fence by long struts having an iron hook at the upper end.

* The Dupommier ladder can be placed in position in less than a quarter of a minute.

Digitized by Google

48. The fuzes are fixed by the method already described, arrangements being made for simultaneous demolition.

49. *Personnel.*—The detachment is commanded by an officer and consists of as many squads as there are bays of fence to be destroyed.

Each squad consists of three men (two charges) or four men (three charges).

There is an N.C.O. to each squad.

50. *Method of Procedure.*—Each squad fixes its charge to the bay of fencing and arranges its detonating fuze, connecting up the latter to the detonator. The N.C.O.'s remain with the slow fuze in their hand ready to light them when the signal is given.

E. ROGERS.

Digitized by Google

NOTICE OF MAGAZINE.

RIVISTA DI ARTIGLIERIA E GENIO.

December, 1911.

THE ENGINEERS IN THE WAR IN TRIPOLI.—The *Rivista di Artiglieria e Genio* reports with pride two orders of the day of the commander of the expeditionary force awarding the highest praise to the Italian troops in Tripoli. The paper adds "To our comrades in the new Italian lands who maintain the fine traditions of the artillery and the engineers, always and everywhere leading to victory, we offer our salutations. But especially the fervent hope for the honour and greatness of the country and that in the performance of their arduous duties there should not be wanting occasions in which their valour will add new splendours to the history of our arms.

The orders of the day are as follows:—

Command of the Expeditionary Forces in Tripoli and Cirenbica.

Order of the Day N. 34.

TRIPOLI, 22*nd November*, 1911.

Subject. Work of the military engineers.

I am pleased to bring to the knowledge of the expeditionary forces the following telegram from His Excellency the Chief of the General Staff of the Army:—

ROME, 21*st November*, 1911.

His Excellency General Caneva—Tripoli 3549.—From all the reports received from the seat of war it is evident that the work of the military engineers fully sustains the noble traditions of that arm for courage, skill, and endurance.

I shall be grateful to your excellency if my name be added as a tribute of the highest praise.—GENERALE POLLIO.

In my order of the day N. 29 of the 15th current I have announced to the troops in Tripoli the excellent work performed by the detachments of engineers.

To the commanders, the officers and the troops of the army, the highest praise that can be conferred is that of His Excellency the Chief of the General Staff, to which I add with warmness my thanks to the officers and troops of the expeditionary force.

The Lieut.-General
Commanding the Expeditionary Forces.
CANEVA.

Digitized by Google

ECONOMY IN WORKS OF DEFENCE.—In the pages of the *Löbells Jahresberichte über das Meer- und Kriegswesen* of 1910, published a few months ago, an important article appears on the above subject. It treats with very delicate questions which have of late years occupied the consideration of military writers, both in Italy and other foreign countries, especially Germany; the same subject was ably treated by General Rocchi in his work *L'economia nelle opere di difesa*, extracts from which were published last year in the *Rivista*.

It is an undeniable fact that during the last decade the expenses for the construction of fortresses have notably increased owing to the ever-increasing efficiency of the artillery. France, which has always been generous in allotting large sums for the defences of the country, has been forced to place a limit on the reorganization of its fortresses, which have been constructed or enlarged since 1870. Colonel Piarron de Mondésir states that only the great places of importance have obtained all the perfections required by modern exigencies, and even in these places all the sections are not of the height which is now necessary.

It is worth noting that, in the sums expended on fortresses, a large part is absorbed by the armament, since the standard of the guns of the defence with their ammunition must necessarily be kept up to that of an attacking force. Of the 755 million francs expended on fortresses in Germany from 1871 to 1908, not less than 171 millions, or about 23 per cent., was devoted to armaments.

It is most important, therefore, in the interests of national economy, to examine the methods by which works of defence may be more economically constructed. High military circles in Germany have lately been carefully considering general complaints that large sacrifices have been entailed in the construction of fortresses.

The funds authorized for defensive work in the first period from 1870 to 1881, amounted to 200 million francs, or about 7 per cent. of the 2,876 millions allotted for military expenses. Had this same percentage been maintained from 1900 to 1907 the amount allotted for defensive work should have been 390 million francs, as 5,590 million francs were the complete expenses for the whole army. As a matter of fact only 115 million francs were allotted, or about 2 per cent. on the total expenses.

The allotments for the defence of the country therefore are not only relatively but absolutely diminished by an annual average of from 15 to 18 million francs. The question naturally arises as to how this result can be satisfactorily obtained. After a careful consideration of the principal German fortresses the following answer is arrived at:—

Only places of absolute importance are retained, and it has been found possible to give greater and more desirable efficiency to these at a moderate cost. Fortresses of secondary importance have been abandoned, and in consequence the following distribution of 570 millions of francs for expenses to the end of 1910:—

Coast fortifications	Millions	54·5.	Equal to 9·6 %.
Great enclosed fortresses ...	„	448·7.	„ 78·6 „
New fortresses	„	42·9.	„ 7·5 „
Remaining places	„	24·1.	„ 4·3 „

Digitized by Google

The expenses of each work are naturally increased with the introduction of armoured plates and cement, and it is an error to suppose that greater efficacy can be obtained for the same cost, by strongly fortifying certain points, and in consequence leaving a number of guns unprotected with armour.

Of 570 millions of francs, expended on fortifications from 1870 until now, only 35 millions or 6·1 per cent. of the total sum have gone to armoured works.

When considering the possibility of arriving at economy in the construction of fortresses, General Rocchi complains that modern fortification is costly, based as it is on antiquated forms and predetermined types, and that in many cases it is superfluous and not adapted to the ground. His verdict on the Italian methods of fortification is very severe, when he asserts that they are fossilized and are the consequences of a too rigid scholastic application of deductions of scientific experiences, and of the habit of treating a work of fortification like an algebraic formula.

General Rocchi believes that he can find a remedy applicable for fortifications both offensive, or defensive. He condemns the spacious detached forts with their casemates and double stories, and with their deep ditches provided with flanking defences. In the same way as Sweitschine, in opposition to Buinitsky, formerly condemned the type of Russian forts, in which the idea was to conceal the casemates with masking defences of great relief, so Rocchi endeavours to give more perfect technical means to such works only, as, by their permanent and positive capacity for resistance, can successfully assist in the defence of the position.

The type of armoured batteries according to him should be the following :—the guns—installed above a mass of armoured cement of the least possible width and depth—in a series of revolving turrets, with reserves in the immediate vicinity ; behind these a communication corridor which should also serve as a place of recovery with a few other local places of recovery at the sides.

The height of the mass of the work should be limited, and great command over the ground is not thought necessary. The obstacles, consisting for the most part of barbed wire, should be under the fire of the rifles, and the organization of recovering places is necessary not only for the artillery but also for the garrison of infantry.

Deep ditches with revetted scarps and flanking defences are only necessary for works which have to resist a regular siege with covered approaches. All the arrangements for an ordinary defence should have the character of lightness and activity. The ammunition for the guns should be stored only in such works as might be isolated for a long time. In other cases, General Rocchi maintains, this would only lead to loss owing to the increased space.

These proposals are absolutely opposed to the present ideas of Italian fortification.

The General condemns recovering places in casemates on the grounds that the troops shut up in them are ignorant of what is happening outside, and that they are therefore morally detrimental.

Digitized by Google

The necessities of the present day seem to call for a simply organized method of warfare, mobile and effective. It is on this principle that the Austrian military writer Hanika bases his remarks on the preparation of fortresses, and affirms for the same reason that the modern armament of strong fortresses does not really satisfy the desired exigencies of the defence.

January, 1912.

LIGHTNING CONDUCTORS FOR BUILDINGS USED FOR THE PREPARATION AND STORAGE OF EXPLOSIVES.—On the 7th June, 1910, one of the buildings used for the washing and filtration of nitro-glycerine in the factories of the Carbonit di Schlobusch was struck by lightning, a very violent and disastrous explosion which completely wrecked the building and seriously damaged other buildings being the result. The building that was destroyed was completely furnished with lightning conductor protective apparatus of a type approved by the Prussian minister of industry and commerce. An enquiry which was opened immediately on the cause of the disaster came to the conclusion that the regulations for the fixing of the above-mentioned apparatus had not been scrupulously adhered to.

Shortly afterwards the Westphälische-Anhalter Sprengstoff A.G.—which had provided its establishments with lightning conductors of the usual type, and had rigorously attended to all the regulations—suffered a serious disaster, and in March, 1911, a new catastrophe happened at Blomfontein owing to the buildings used for the preparation of nitro-glycerine being struck by lightning. In consequence of these disasters Dr. Von der Hagen was deputed by the Sprengstoff Actien Gesellschaft Carbonit to study the subject, and to give definite replies with regard to the efficacy of the arrangements until now adopted for the protection of buildings against electrical atmospheric discharges.

Dr. Von Hagen in a lucid article in the *Zeitschrift für das gesamte Scheifs und Sprengstoffwasen* has given the results of his observations and comes to the conclusion that the arrangements hitherto in use are absolutely insufficient and ill-adapted for their purposes.

At the same time as Dr. Von Hagen, Professor Rinkel was occupied with the same questions and his conclusions were almost identical, and in consequence of these reports the Prussian minister of industry and commerce approved, by a decree of 13th November, 1906, of a series of regulations regarding the fixing of lightning conductors in the factories and depôts for the storing of explosives.

The protective apparatus for factories used for the manufacture of high explosives and surrounded by earthen embankments should be thus constructed:—(*a*). An external network placed far from the building for the purpose of arresting the action of electric discharges. (*b*). An inner network to arrest partial discharges which might escape the action of the outer network. (*c*). Arrangements for security relative to the metallic conductors and to all metal objects in the interior of the building. The outer network should be of zinc or copper $\frac{2}{3}$ m.m.^{2} in section. It should be supported at a height of about 1 m. on a series of iron rods placed above the earthen embankments. The rods *s* are also in contact with the

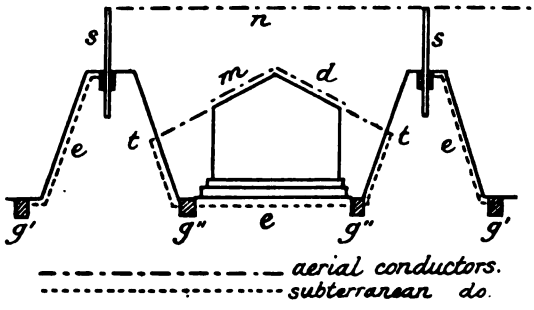
Digitized by Google

soil by means of another metallic conductor g'' enclosed in small wooden cases.

The above-mentioned rods are joined with another conductor g' in the same manner, but forming a ring at the foot of the external scarp. Both the conductors g'' and g' are sunk to a depth of about $\frac{1}{2}$ metre in the earth.

If there is water in the vicinity two of the conductors should be submerged by metallic prolongation with wide plates at the extremities. When there is no water at least two of the conductors should have four or more diverging branches with a length of about 10 metres and a depth of about $\frac{1}{2}$ metre beneath the earth.

The inner network (m) should be of zinc netting about 2 m.m. in diameter, and should be supported on the roof of the building. This network is also connected with the earth by means of lateral conductors: two subterranean conductors f and g surround the building.



The internal network may be dispensed with in the case of buildings which do not contain large masses of metal. All the metallic objects contained in the interior of the building should be absolutely isolated from the interior network: the Minister orders that tests for the lightning conductor apparatus should be made if possible at the beginning of March.

Every four or five years the subterranean conductors should be opened out at different points to ascertain if they are in a good condition and well connected with the network. It is also thought necessary to test the electrical resistance of the soil surrounding the conductors.

Lightning darts in a zigzag manner, and always with an oscillatory discharge of the same nature like the discharges from Leyden jars. Its length varies from 3,000 to 1,000 metres; and the intensity of the current may sometimes be above 20,000 amperes with a tension of several millions of volts. The earth is charged by the influence of the electricity in a manner contrary to that of the clouds, and the potential difference increases up to saturation by ionization of the strata of the interposed air. It is impossible to study the phenomena of lightning from Leyden jars, and to maintain the proper proportion of distance because the sparks produced in the apparatus are evidently too short.

Dr. Von der Hagen has made a series of very interesting experiments of which a full description is given, and on the whole he is of opinion that the dangerous effects of lightning are difficult to demonstrate practically,

Digitized by Google

because the current employed in the experiments is always less in intensity than that of atmospheric discharges. He writes that his researches are not yet completed.

Professor Rinkel has also made similar researches and studied a method of protecting buildings used for the manipulation and fabrication of explosives, from atmospheric discharges (effects of auto-induction, oscillatory discharges). He observes "we are not yet satisfied that owing to the enormous intensity and the high potentials of atmospheric electricity the networks are sufficient to impede the effects of auto-induction and with these the secondary discharges which always follow the first."

In considering the important studies of these two German scientists relative to the system of protection against atmospheric electrical discharges we arrive at the following conclusions, viz. :—(1). The great efficiency and usefulness of lightning conductors placed as rods above the earthen embankments surrounding the buildings. (2). The small utility of horizontal networks, and their danger from the strong effects of induction caused by these. (3). The use of vertical metallic networks connected with the lightning conducting rods. These have the effect of lowering the potentials at the moment of discharge. The more the metallic masses of the networks are increased, the less will be the danger caused by the presence of metallic masses in the interior of the building. (4). The great importance of circular connections above and below by means of thick metal bands with all the metal apparatus within the building. (5). The necessity of all the metal apparatus within the building, as well as that used for protection, being in connection with the earth. (6). The necessity for metal pipes (for gas, water, etc.) being always underground. (7). The use of a *short* and *thick* lightning rod placed on the summit of the roof of the building. This rod should have its own metal conductor and should be in perfect connection with the earth.

E. T. THACKERAY.

Digitized by Google

CORRESPONDENCE.

PASLEY ON NAPOLEON.

DEAR SIR,

The following letter, written by Sir Charles Pasley, which appeared in *The Times* on the 16th November, 1813, will, I think, be found interesting at the present time. It shows very clearly the wonderful manner in which he foresaw the right way to crush the power of Napoleon. The letter has been kindly placed at my disposal by Miss Tyler, the grand-daughter of the author of the Essay on the Military Policy of the British Empire.

It is right and fitting that we should, during this centenary year, do honour to the memory of Pasley as the originator and founder of the S.M.E. It is well however that we should also recognize the great influence which he exercised over the actual Military Policy of the Empire, the insight which he displayed in his book as regards the true principles of war, and the sound judgment shown by him in realizing the probable advantages to be obtained by an offensive campaign in the Spanish Peninsula.

Yours faithfully,

25th April, 1912. B. R. WARD, *Colonel, R.E.*

To the Editor of the "Times."

SIR,

I herewith transmit a paper, which you are at liberty to publish if you think it will be acceptable to your readers. It was written by me in the year 1809, after my return from Corrunna, but previous to the sailing of the Walcheren expedition. I had an intention of producing it in my Essay on the Military Policy and Institutions of the British Empire. If I had followed my original plan of discussing the Institutions at large before the Policy, it would have appeared in the First part of that work published in 1810.—It was shown to Capt. Tailour R.N. and to many other private friends, at or soon after the period, when it was actually written; otherwise I should have had great hesitation in now publishing it, as it might be suspected to have been composed, not before, but after, and in allusion to, the late glorious public events. At the period of disaster and despondency above mentioned, although I foresaw the practicability of making an impression on the French Empire, by a vigorous display of our military strength, yet I must confess I had not the smallest hope that the attempt would ever have been made on a scale capable of ensuring success. The perusal of this paper may therefore place in the strongest light the wonderful change for the better, which under Providence, has been effected in our National affairs, through the wisdom, energy, and perseverance of the executive Government of this country, within the short period of four years; since it calls to mind the former gloomy impressions and Resperts (?) which had resulted from the former unenterprising mode, in which our military operations had been planned and conducted, during the first years of this memorable war. Impressions which had been of late almost obliterated from our memory, in consequence of the series of brilliant Victories achieved by Lord Wellington in Spain, and subsequently by our continental Allies in Germany. It will be seen that the Ideas and general mode of reasoning contained in this paper, correspond with that part of my Essay which has appeared before the Public, and that even some of the observations have actually been introduced in it. Having for the last three years been prevented by my military duties from proceeding in the remaining part of that work, I have not looked over any of my old manuscripts composed with that view until a few days ago, when the enclosed paper, of which I had but a faint recollection appeared of such a striking nature that I thought it likely to prove interesting at the present moment.

I am &c

CHATHAM LINES *Novr. 12th.* C. W. PASLEY.

Extract from one of the Chapters of an Essay on the Military Policy &c. of the British Empire, written in 1809, but not before published; the first part of which Chapter related principally to the comparative organization of the French and British Army :—

Digitized by Google

"I shall now lay before my readers the effective force of the British Army, according to the Official returns presented to Parliament from the Adjutant General's office dated 26th Febry 1809:—Effective Cavalry British and German, 27,356; Effective Infantry, including foreign Corps, 183,258; Effective Militia, 81,577; add for the effective strength of Ordnance Corps, 20,900; Total, 313,091.

Great Britain therefore from the most authentic information to be had, does at this moment maintain in constant pay an Army of more than 300,000 men, and yet such is the badness of her military Policy, whose errors I have before noticed, that with so large a force, she is incapable of doing any thing on a great scale; incapable of giving any efficient aid to her Allies, or of inflicting any serious evil upon her enemies.

Let us suppose that any one had told Hannibal the exact situation in which this country was to find itself at this moment, describing its force and prospects, and the force and views of our enemies: What would he have said?

"Great Britain you tell me" he would say, "has nearly annihilated the whole of her enemies' fleets, and rules despotically by sea. She also possesses an effective army of 313,000 men, and has nothing to fear at home. She will therefore no doubt send 150 or 200,000 Men abroad, to carry on War in the heart of France, whilst the French Armies are on the Vistula, and beyond the Alps and Pyrennees. She will maintain this force at the expense of France, and thereby strike at the very heart of the enemies resources, who will consequently be obliged to withdraw his forces from foreign countries, and to abandon his conquests with all the revenue and force he derives from them, in order to defend himself at home. In the meantime Great Britain, which you say was able to maintain 313,000 soldiers by her own native resources and revenue, when she comes to find so large a portion of them in France, will have a considerable part of her revenue free wherewith she may raise and pay more men in order to form supplymentary Armies of her own and at the same time bring forward powerful Allies to act on all sides of the frontiers of France; whilst she herself carries on a desperate attack in the very heart of that country in the way I attacked, and would have destroyed the Romans had not the Senate of my country, blinded by commercial notions and distracted by factions withheld the necessary supplies of men and money from me. This is of all modes of attack the best, when circumstances permit, or authorise it,—this therefore is the mode which Great Britain with all the vast power which you say she possesses, will undoubtedly adopt."

But if it were explained to Hannibal, that the frontiers of France, on almost every side, were so strong by nature and art, that supposing our Allies acted with the greatest vigour, they would have to penetrate double or even triple fortresses; consequently whilst they were engaged in tedious and destructive sieges, the French might keep them in check with a small portion of their force, and bring the greater part of it to overwhelm us. Besides which that even if the coast by which we should have to enter the enemy's country, presented numerous fortified places, amongst which were all the important Harbours, so that we could not ourselves venture to move forward, nor could we feel at all secure after our landing, until we had taken two or three fortresses which would occupy our Army so long, that the enemy would bring a superior force against us before we could strike any blow of consequence: and that independently of this objection there was another insuperable one, which was that our Armies were not organised, as to undertake any siege with any fair prospect of success.

Hannibal would then reply: "These people whom you call French seem to have acted with great wisdom, in making themselves strong and almost invulnerable at home, before they set out in their career of foreign conquest; But you astonish me by saying the British cannot undertake a regular siege. However as Sieges depend on the application of ingenuity and the mechanical arts, to War, and as you tell me the British are a learned ingenious people, and abound in skilful Mechanics and Artificers of every description, they will of course soon remedy this defect in their military establishment. Less than a year will suffice to organise their Engineer Corps, so as to be equal to the most arduous Sieges. In the meantime as you say that Spain is universally hostile to the French, but unable of herself to shake off her yoke, the British will, no doubt, send 150, or 200,000 Men into that country, which by the co-operation and goodwill of the Spaniards, will be more than equal to any Army that France can oppose to them there. Having driven the French out of Spain, and taken the few remaining Spanish fortresses they occupied, which, when their Armies were beaten out of the field, would not be a difficult task; the British would then in concert with an allied Spanish force, cross the Pyrenees, and carry the war into the heart of France, in order to strike at the source of the enemy's power, on the principles that I before suggested. The undertaking will be perfectly practicable, and exposed to none of the hazards of the former scheme, which was the first that

Digitized by Google

naturally presented itself to my mind, before you explained to me the wise and judicious plan, on which the French have secured all other parts of their frontier. The rigorous attack on the side of Spain, which I propose would throw the French into the utmost confusion. They would be obliged to withdraw all, or the greater part of their force from Germany; the friends of Great Britain would then gain confidence; the little States in alliance with France would either abandon her, or be subdued by Austria, who would, of course, declare herself, as would also all the other powers that were secretly hostile to France. Italy would revolt as well as Switzerland. In short the French in consequence of such rigourous measures, would be obliged to evacuate all the countries beyond the Rhine and Alps, and bring their Principal force to defend themselves on this side the Pyrennees. But by evacuating these countries they would lose a great portion of their revenue and the considerable Armies which they now derive from them. They would therefore no longer be able to support nor to recruit their Military establishment to its former extent, and as long as you would vigorously carry on the War, in the way I propose, you would every day become comparatively richer and more powerful whilst your enemy becomes poorer and weaker. In the end you might even destroy him, certainly you would break his power, so that he could not attempt with any reasonable hopes of success, to overcome any nation protected by you."

After having expatiated in this manner, on the way that Great Britain might, and in all probability would, carry on her Wars—If Hannibal were told the way in which she actually does conduct them, he would then say: "The People whom you describe to me are exactly the reverse of what Pyrrhus described the Romans to be, you say they are civilized and enlightened, but it appears to me that they have nothing but barbarism in their military Policy and Institutions. You say they have nothing to fear at home, and 313,000 soldiers to dispose of, and yet you tell me they never do send, and by some unaccountable error in the distribution of their military force, that they absolutely *cannot* send more than 20 or 30,000 men to carry on War in any part of the World; against whom their enemy may in a short time bring a force of 2, or 3, or 4 times as great. The small Republic of Athens, that had not half the resources of one City in the country you mention, sent as large an Army against Syracuse as this nation ever employs. You tell me that instead of acting on a wise and vigorous System of Policy, these people are guided in their military operations by the News of the day, that they will embark one of their ridiculous little armies because there happens to be good news from Spain; stop its sailing because a rumour of bad news arrives; and send it after all on some other change of news; reinforce it, recall it, in short give it a thousand contradictory orders because of the news of the day. Now a nation that acts in this way like a miserable stock-jobber, fluctuating and speculating on the News of the day, cannot possibly prosper in War. A great nation should act on a sound system of military Policy; neither suffering herself to be frightened from her object by bad news, nor elated by rumours of success. She ought to form her schemes in such a way as to command success, and send out her Armies on such a scale as to create good News.

"It is not difficult," Hannibal would add, "to foresee the fate of a Nation, that seems to me to act with so little wisdom and firmness. If instead of 313,000 Men, as you say she possesses, she had a million of the bravest soldiers in the world in her service, since she has neither the sense nor the energy to make a proper use of her Troops, she would continue to send out, petty, despicable little expeditions from time to time, like the paltry sorties of a few brave men from a besieged Fortress, who may give a little momentary trouble but are always certain of being driven back. Her enemy may in the meantime be teazed and provoked by these little attacks, which he will despise, but will never be diverted by them from any grand object. Consequently he will go on conquering the rest of World, until he find at some future period, a favourable opportunity of successfully attacking a Country, which having so little foresight, wisdom and energy, will not be able to make any effectual resistance."

This reasoning which I fancy Hannibal would have used in regard to the present Policy of the British Nation, is, I am persuaded, the sentence that will be passed upon it by an impartial posterity, when we shall come in review before the great tribunal of History, on a par with Rome and Carthage and other mighty states that are no more, to be judged by men, who will despise our Parliamentary parties, just as much as we now do the Green and Blue Factions in the Circus at Constantinople; who will be as little disposed to respect us for our Riches, as we now do the Memory of Crœsus, or the character of the Sybarites, and who will soon deny, what what we now proudly deny to other nations—the being possessed of any real patriotism, for (which is the only true criticism) they will judge of us, not by our speeches in our Sena r the paragraphs in our Newspapers, but by our public measures and actions, and by t. s which result from them."

Digitized by Google

A PONTOON BRIDGE FOR STEAM TRANSPORT.

SIR,

In the letter from Major Matheson, R.E., published in the March *R.E. Journal*, some points are brought up as regards the hypotheses of my calculations for a Pontoon Bridge for Steam Transport. The chief question centres round the extra factor of safety for live load.

I always understood that such a factor was necessary not only because a load travelling across a bridge could produce a greater strain than if stationary, but because the constant variation (and in this case, reversal) of stresses weakened the fibres of the road-bearers *after a time*, especially when the deflection was appreciable.

If I am correct, a test lasting only a short time, such as is referred to at the end of Major Matheson's letter, does not allow fully for this extra factor of safety, unless the baulks used have before been frequently under an equal strain. As to the correct amount to allow for this extra factor for moving loads, I think it is usually admitted that the stresses caused by the driving axle of a mechanically propelled vehicle are always greater than they would be if that vehicle was not self-propelled. As $1\frac{1}{2}$ to 1 is the extra factor in the case of ordinary transport, I have allowed 2 to 1 for mechanical transport, but this may be too great a difference.

I think Major Matheson is right in saying that, in the case of a floating bridge in calm water (as is usually the case), these extra factors of safety might be reduced.

The point raised as to "the pontoons *b*, *c*, *d*, sinking evenly under the load" is the fault of ambiguous wording on my part, but the paragraph and calculations following show that the deflection of the baulks *bd* is allowed for.

The weight of superstructure was taken from the table on page 133 of Part 3, *Instructions in Military Engineering*, allowing double that given there for medium bridge.

The width of baulks was obtained by measurement at Upnor. All the old baulks there that I measured, and some of the new ones, vary in width from $2\frac{7}{8}$" to $3\frac{1}{8}$", only a few of the new ones being $3\frac{1}{4}$" wide, from which dimension a slight allowance must be made for the hollowing out along the centre of the baulk.

These latter points as to weight of superstructure and widths of baulks have, however, very much less effect on the number of baulks required to carry any definite load, than has the amount of the factor of safety necessary, a question for the determining of which I have little practical experience to guide me. Whatever this factor is taken to be, I hope the result of my work may be of some use as regards a comparison of the different ways of arranging the superstructure under the varying circumstances that may arise.

Yours faithfully,

W. L. CAREY, *Capt.*, *R.E.*

Chatham, April 28th, 1912.

The Editor, *R.E. Journal*.

Digitized by Google

A SURVEY PROBLEM IN SIEGE WARFARE.

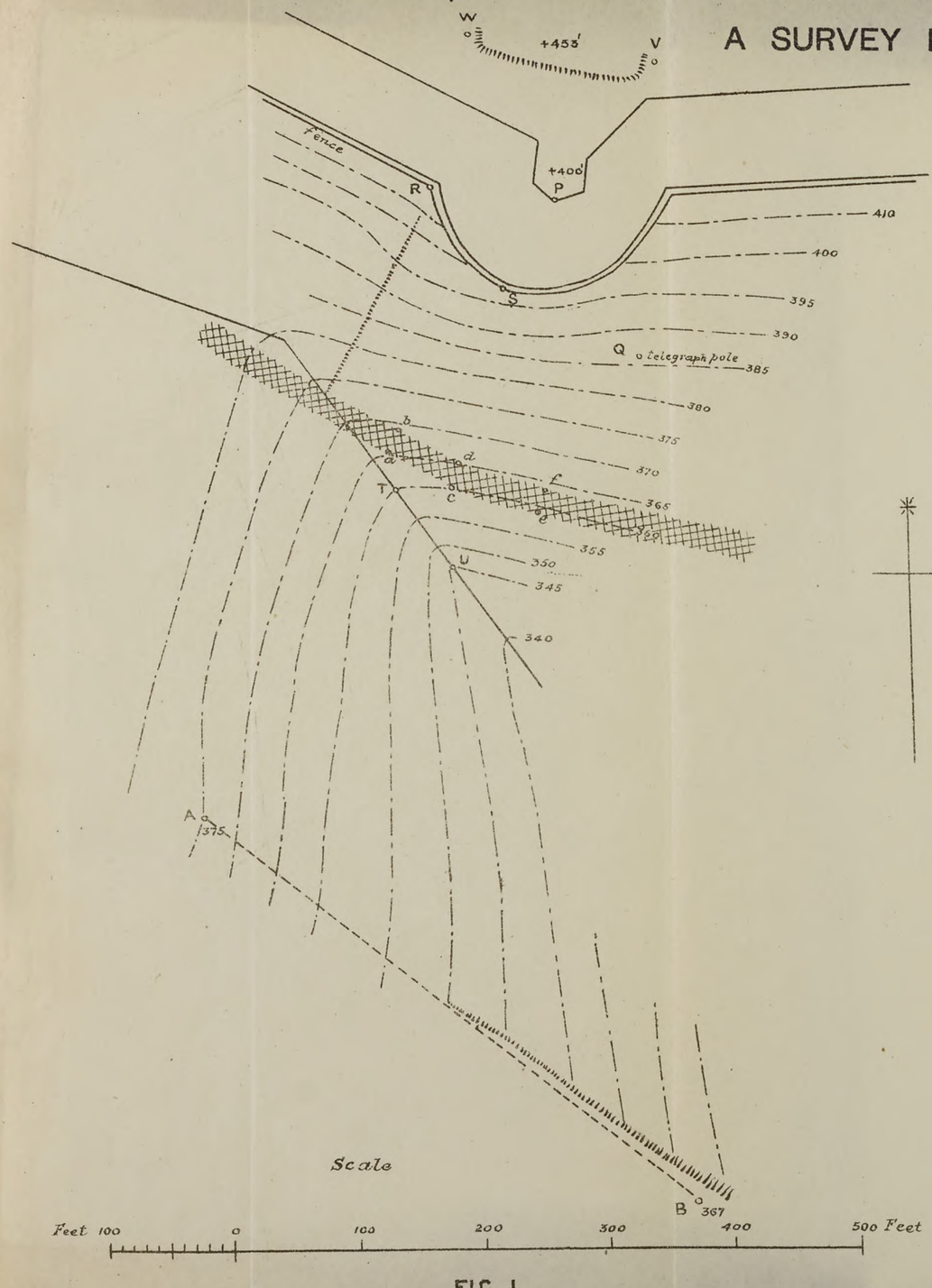


FIG. 1.

WORK "Z" SKETCHED FROM SAPHEAD A LOOKING N.N.E.

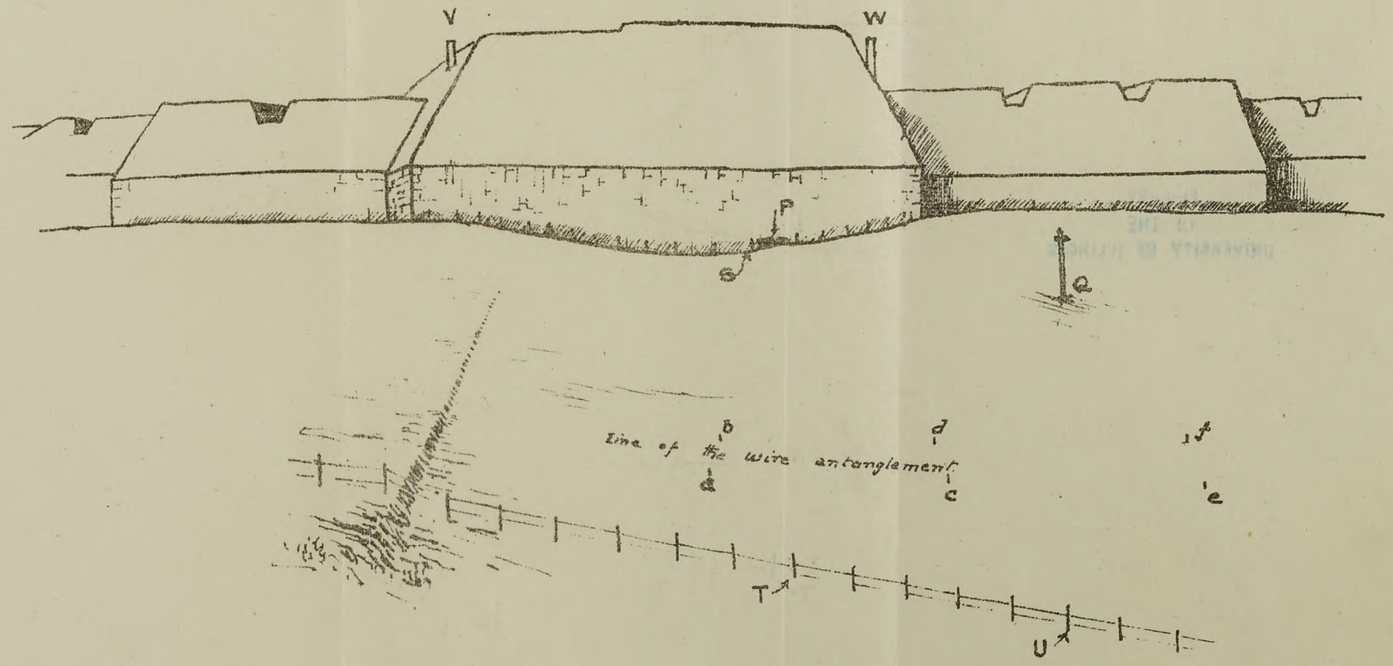


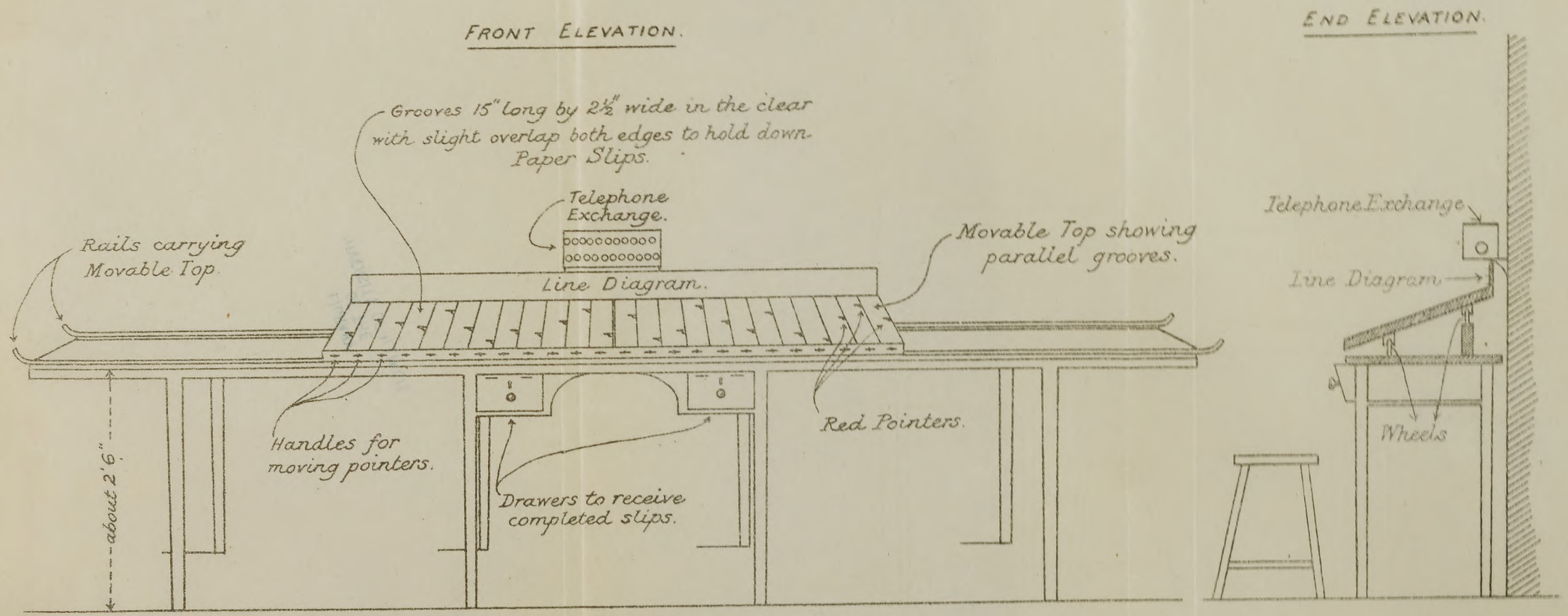
FIG. 2.

Digitized by Google

Digitized by Google

A.B.C. SYSTEM OF TRAIN CONTROL.

CONTROL TABLE.



Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

UNIVERSITY OF ILLINOIS-URBANA
3 0112 118408381

Digitized by Google